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By WALTER C. ALVAREZ, M.D.

Assistant Professor of Research Medicine, George Williams Hooper Foundation for Medical Research, University of California Medical School

SAN FRANCISCO, CALIFORNIA

MR. PRESIDENT, Members of THE AMERICAN ROENTGEN RAY SOCIETY: I wish first to thank you for the great honor you have done me in asking me to give the first Caldwell Lecture. It is a pleasure to join with you in remembering the name of one of the martyrs of medicine—a man who gave his life for the advancement of science. He was a pioneer, an inventor, a research worker, a versatile, enthusiastic and lovable man; and we are all losers by his death. We shall honor him best by carrying on the work which he loved so much, and which meant everything in life to him. I believe we shall carry it on most rapidly when we do as he did, when we venture out into "pure" science—into physics, chemistry and engineering, to improve our apparatus; and into biology, physiology and bio-chemistry to explain our findings in the body. How much more rapidly our transformers and tubes would have been improved if there had been more men like Caldwell at work in the field; and how glad we should be to-day that some manufacturers have at last seen the incalculable benefits that can come through proper co-operation with a physicist like Dr. Coolidge!

Every advance in technique brings its problems of interpretation. I shall never forget my delight when, in 1912, I got my first radioscope from Vienna and saw the peristaltic waves coursing over the stomach. At first it seemed as if all my desires had been fulfilled, but in a few months this feeling of satisfaction gave way to one of worry over the many things which I saw but could not interpret. I went East and told my troubles to Cannon, who frankly admitted that many of our pathologic findings are not explainable on the basis of the myenteric reflex or the acid control of the pylorus. He gave me room in the laboratory and told me to go to work on these problems myself. He showed me how to open an (anesthetized) animal's abdomen under salt solution so that I could watch the peristaltic movements. Two or three days of this and I saw that the problems I had set for myself were too big and too complicated. I was like a man who would repair a wireless telephone without first knowing the structure and inner workings of the constituent batteries, induction coils, condensers and magnets. It was clear that I had to begin back near the beginning, on problems which to an onlooker might appear to have no promise of practical value. The intestine is a tube made up of smooth muscle and it seemed to me that if I could learn more about the properties and peculiarities of that tissue I would come near to solving some of the riddles of peristalsis. Hence it is that for the last seven years I have turned somewhat aside from the clinical journals and have delved into the literature of the experimental zoologists, the physiologists and the comparative anatomists. I have studied smooth muscle in organs other than the bowel—in the bladder, the ureter, the vas deferens, the uterus, the arteries and the iris. Many helpful suggestions have been gotten from studies on snails, sea-cucumbers, anemones, jelly fishes, clams, worms and crayfishes. I have found the medical indexes almost useless in this work, because the most helpful articles are often concealed behind the most uninviting titles. Thus, who would have expected to find an explanation for the gastric upsets of fevers and asthenic states in an article on the swimming plates of a tiny water organism?—yet there I believe it is. The author is Professor Child, a zoologist, and the article is entitled, "The Gradient in Susceptibility to Cyanides in the Meridional Conducting Path of the Ctenophore Mnemiopsis." [1]

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It is unfortunate that we practicing physicians must often miss the most thought-stimulating articles because they are buried away in the highly technical journals which we do not ordinarily read. Some day we may have a better abstracting service, but in the meantime we shall probably have to do occasionally as the Israelites did when they approached the Promised Land; we shall have to send out spies to look over this field which we ourselves have so little time to explore, and to bring back some of the fruits. When asked to speak before you to-day, it seemed to me that the best service I could render would be to bring to you some of the ideas which I, a practicing physician and radiographer, have gotten during my sojourn among the physiologists.

THE AUTONOMY OF MANY PARTS OF THE BODY

The first of these ideas is that *the forces which bring about, modify and control peristalsis must be looked for mainly within the walls of the gut itself.* I cannot too strongly emphasize this point, because it seems to me that the failure to grasp it is the greatest stumbling block to further advance in the knowledge of our subject. Whenever I describe some of the regional differences in behavior which can easily be demonstrated in the excised stomach and bowel, someone is almost sure to say: "Oh, that is due simply to the autonomic and the sympathetic." Another settles the whole problem by calling it a "Reflex." When I point out that the peculiarities persist in little pieces of muscle which have been cut out and kept in the ice box for several days, these individuals still ascribe everything to the activities of the canny little ganglion cells in Auerbach's plexus.

Now, the most paralyzing thing in scientific work is a facile explanation which puts a stop to further curiosity without really advancing our knowledge of the subject; and I have never been able to see the value of pushing the explanation for a mechanical phenomenon out of the organ in which it might be studied, and into a tiny ganglion where we can hardly follow it. It seems to me that many even of the teachers of physiology have a wrong idea of the nervous system and its relation to the viscera. They look at it somewhat as an electrical power house which not only supplies the motive force but controls the activities of the various trains running over a railroad. My analysis of the literature makes me feel that we should look at it more as a telephone switchboard with wires which carry nothing but messages of warning and advice from one engineer to another. The trains supply their own power; and the differences in speed and other activities are due to peculiarities in fuel, differences in the gradient of the road, etc.

Anyone who will study the behavior of the lower forms of life before and after removal of their nervous systems will see that the nerves are there primarily to expedite conduction. The ganglionic cells are nutritional centers and not storehouses of wisdom and power. Some of the most complicated "reflexes" are performed by decerebrate animals or by excised parts of these animals. Loeb, Parker and others have shown clearly that the mechanisms are local and comparatively simple.

THE MYOGENIC NATURE OF THE RHYTHMIC CONTRACTIONS

Similarly, in the gastro-intestinal tract we find that after the preliminary shock has worn off, digestion goes on quite normally after complete section of the vagi and the splanchnics. We get good peristalsis in the stomach and intestine that have been removed from the body and either perfused or placed in oxygenated Locke's solution. We get active peristalsis in small segments of gut and in pieces of muscle stripped from the wall. It is clear then that the gastro-intestinal tract is autonomous: it carries within itself all the mechanisms essential to peristalsis.

The next question is, what part is played by the muscle and what part by Auerbach's plexus? Practically all writers on the subject state that the rhythmic contractions are due to stimuli coming from the ganglion cells of the plexus. They base this opinion on the first few papers by Magnus, who found that strips of circular muscle from which the plexus had been removed did not contract rhythmically. Unfortunately no one seems to have noticed that in his fifth paper,[2] Magnus admits that these same plexus-free strips did beat when he added a little physostigmin, strophanthin or barium to the solution. Moreover, no one notices the work of Gunn and Underhill [3] who repeated these experiments, and by taking greater precautions to avoid trauma, obtained plexus-free strips which would contract rhythmically without the help of tonic drugs. This is what we should expect, because it has been well proven in many ways that rhythmic contraction is a function of muscle itself.

It is clear then that the man who would understand peristalsis and the various activities of the stomach and bowel must pay particular attention to the properties and reactions of the gastro-intestinal muscle. Some may ask: what then is Auerbach's plexus good for? It almost undoubtedly serves for the conduction of stimuli and the coordination of movements; it enables the muscle to respond properly to stimuli coming from the underlying mucous membrane, and it helps in some way to keep that muscle from contracting down into a hard knot. Such contractions are well known to biologists, and somewhat resemble the spastic paralyses of striated muscles.

THE AUTONOMIC AND THE SYMPATHETIC

The next question is: what is the significance of the vagus and sympathetic nerves running to the intestine? The average clinical writer to-day states that the autonomic (vagi and sacral nerves) stimulate, and the sympathetic fibers inhibit the intestine. Disease is supposed to follow an unbalance between these two effects. This unbalance can be diagnosed and corrected by the use of certain drugs which are supposed to be elective in their actions. These theories of vagotonia and sympathicotonia have had a strange fascination for the medical mind; they have been dragged in with the utmost assurance to explain all sorts of disease states; and I believe have had a most unfortunate influence on our conceptions of gastro-intestinal physiology. It may be that these theories will eventually prove useful; but in my opinion their foundations are so shaky that some day the whole edifice is going to go. In the following brief discussion I can only point out a few places in which the proponents of these theories have made things much simpler than they really are.

Although in the main, the vagus tends to stimulate and the sympathetic to inhibit the stomach and bowel, these effects are generally transient, often indecisive and not infrequently reversed. They vary with the strength of the stimulus and with the condition of the muscle. The next objection is that the whole theory of "nerve endings" and "intermediate substances" is shaky. Leading pharmacologists have for some time been calling attention to the many contradictions in the literature of the subject, and have warned us to be careful in accepting physiologic conclusions based upon the supposed activities of the various nerve poisons.[4]

Perhaps the strongest objection to the recently revived theories in regard to the autonomic and sympathetic systems is that they make it appear that the sympathetic nerves with the celiac ganglia constitute a separate and distinct brain system which can be antagonistic to, or out of harmony with the central nervous system. This view is entirely at variance with the facts, which have been collected and discussed in a masterly way by Gaskell in his monograph on "The Involuntary Nervous System."[5] He shows that the involuntary nerves and ganglia are a part of the central nervous system; they are connected with it just as the voluntary nerves are, and they have developed from the same embryonic cells. The main difference is simply that the motor ganglia which in the voluntary system are found in the anterior horns of the cord, have migrated, some as far as the paravertebral ganglionic chain; some into the solar plexus, and some into the nerve nets in the walls of the hollow organs. Hence it is that the rami communicantes or preganglionic fibers in the sympathetic system, and most of the efferent fibers in the vagus are simply elongated connector neurones such as we find between the motor and sensory roots in the cord, and in the pyramidal tracts. Furthermore, it has been shown that there are no commissural fibers between the different sets of sympathetic ganglia such as would have to be present if these ganglia were to mediate reflexes like an abdominal brain.

VALUE OF THE EXTRINSIC NERVES

We learn then from Gaskell the same lesson that we have had from Loeb and from Parker: that the nerves are there to conduct, and not to exercise faculties requiring almost human intelligence. There are times when the animal as a whole needs to communicate with its digestive tract; there are times also when the tract must communicate with the body. There are many times when one end of the tract must communicate with the other; and on all these occasions the extrinsic nerves come into play. The vagi carry feelings of hunger and of satiety from the stomach to the brain; they help in adjusting the tone of the stomach wall to the food coming down the esophagus; and they carry the stimuli that give rise to the psychic secretion of gastric juice. If the food must be rejected by vomiting they carry the impulses which bring the abdominal muscles to the aid of the stomach. They probably carry messages from the digesting tract which make the animal feel comfortable and sleepy. The splanchnics serve largely to quiet the tract and to stop digestion when the body is distressed or injured. The extrinsic nerves probably have much to do with the digestive upsets with disease elsewhere in the body; but we shall see later that these changes can be accounted for also by actual damage to the gastro-intestinal muscle.[6]

I regret that I have had to spend so much time on this subject of nervous control; but it seems that the human mind is not so ready to look for new explanations for well-known phenomena, or even to accept them when found, until its contentment with the old explanations has been disturbed. Now that we see how autonomous the tract is and how dangerous it is to rely on theories of ganglionic control, we should be the more eager to learn all we can about the gastro-intestinal muscle.

SMOOTH MUSCLE

As you know, smooth muscle is made up of spindle-shaped cells which vary in size, shape, number of nuclei, etc., in different animals and in different parts of the same animal. As a rule it contracts more sluggishly than striated muscle does; it takes longer to get started, and it is slower in recovering its original length. After a number of strong stimuli or sometimes after only one, it may become quite refractory. After a long rest it may seem to get on a hair trigger again so that it responds powerfully and explosively to a slight stimulus. That is the condition of the digestive tract after the night's rest; and it probably has much to do with the fact that most of us have the daily bowel movement in the morning, immediately after breakfast. With an animal open under salt solution, one can often start a rush wave down the bowel by pinching the duodenum. For some time afterwards, similar pinches will have no effect, but if we wait long enough we will again find the bowel so sensitive that the slightest stimulus will start a wave.

Another characteristic of smooth muscle is its ability to maintain a firm and lasting contraction without fatigue. We see this in the muscles which close the shells of bivalves and we see it in the wall of the colon. It is interesting that the muscle in a bivalve consists of two parts: one which closes the shell and the other which locks it closed. By cutting first one and then the other it can be shown that neither one can do the work of the other. Similarly, if one of you will try to hold his arm out perpendicularly to his body he will soon find it a most painful and fatiguing experiment. The deltoid was not designed for such heavy work, but the glutei and back muscles are carrying much heavier loads all day, and they do not complain. There are all kinds of muscles, all suited to different purposes. Some, like those in the wings of insects, must contract 300 times a second; others like those in the wings of a hen have little to do. Those who think all muscle is the same forget the diffenences between the white and dark meats of chicken, between the heart and the gizzard; between the tenderloin, roundsteak and tongue. I have gone into these differences so at length to prepare you for the thought that there are big differences between the muscle in the cardiac and pyloric ends of the stomach;[7] between that in the small intestine and that in the cecum [8] and colon.[9] The muscle on the lesser curvature near the cardia is soft to the touch like coagulated fibrin; that in the pyloric antrum is tough like gizzard and has a different color. Stimulate the two with an electric current or with a pinch and you get two entirely different contraction curves; put them into warm oxygenated Locke's solution and you get two different types of rhythmic activity. These differences were to be expected when we remember that the upper and lower ends of the stomach have different kinds of work to do. The upper end serves largely as a hopper to hold the food; the lower is the mill that does the heavy work. More of these local peculiarities will be described later.

Another characteristic of smooth muscle in hollow organs is its responsiveness to tension. Most of the manifestations of peristalsis are brought about and regulated largely by the internal pressure due to the presence of food or gas. Cannon has shown that the rhythmic segmentation in the small intestine is due simply to the fact that those muscle fibers which are stretched tend to contract.

Smooth muscle shortens also under the influence of direct irritation. Thus we find contraction of the cardia, pylorus, ileo-cecal sphincter and anus when there is ulceration or inflammation near by. We find hour-glass contractions of the stomach opposite ulcers on the lesser curvature; and shrunken and irritable duodenal caps with ulcers in that region.

PERISTALSIS

If we stimulate the smooth muscle in a tubular organ like the intestine or ureter, we get a contraction which produces a tonic ring. From this ring, waves are given off in both directions. They remind one of the ripples which arise at a point where a stone has been thrown into a pond. The impulse spreads from muscle fiber to muscle fiber, and need not be mediated by nerves, ganglia, centers or reflexes. I have observed, after electrical stimulation, similar waves spreading both ways along the segments of a recently voided tapeworm; and I have seen them traveling away from the ridge which forms when one strikes the irritable pectoral muscles of a consumptive. It seems to me that the stimulus probably increases the chemical activity at the point where the tonus ring forms; it raises the metabolic rate, and stimuli spread out on both sides down gradients of chemical activity.

GRADIENTS

Returning to the simile of waves spreading in water, it seems to me that some tubular organs may be likened to ponds which are level to begin with; others are more like rivers which have definitely established gradients. In the first case the waves spread equally well in all directions; in the second, the waves spread better down stream than up. Perhaps I can illustrate my point best by showing the evolution of the fixed gradient in the heart. As you know, in that organ the beat follows a gradient of rhythmicity from the sinus to the ventricle. It was Gaskell who showed that if we cut a heart into three or four pieces the one containing the mouths of the great veins will show the greatest tendency to beat rhythmically, and will have the fastest rate. The ventricle will be slow to start beating and will have a slow rate. Now, when we turn to the primitive heart of the sea slug (aplysia), we find a tube which apparently has no constant gradient in either direction. Its beat arises now on one side and now on the other, depending on where the blood produces the greatest tension. Hunter could find no sign of a gradient in the heart of one of the ascidians. In these animals the beat runs for a while towards the viscera and then for a while towards the gills. The pace-making end seems to get fatigued; its rate is slowed and finally the other end is able to assume the pace for awhile. A constant direction of contraction may be maintained by electrical stimulation of either end of such a heart. It seems to me that Hecht's [10] studies on ascidia atra show us the very beginning of the fixed gradient which we find in the hearts of the higher animals. He found that although the heart of the ascidian reverses its beat from time to time, the sum of the advisceral beats is about twice that of the abvisceral. Moreover, as we should expect if the gradient is a little better in the advisceral direction, the rate of conduction is definitely faster in that direction than in the other. If a wave is started in the middle of the heart going both ways it tends to efface the abvisceral waves which according to our theory would have the smaller momentum. It is interesting also that under slightly adverse conditions, as after warming the water or after diluting or concentrating it, it is the abvisceral beat which is suppressed. We find a little more stable, but still reversible heartbeat in the sharks and rays. In them the slightest stimulus to the bulbus aortae will reverse the beat and the same stimulus to the sinus will restore it. Even in the higher vertebrates the heartbeat can be reversed temporarily by agencies which lower the rhythmicity of the auricle or raise that of the ventricle.

There is considerable evidence now that peristalsis in the ureter follows a gradient of rhythmicity from the kidney to the bladder,[11] and I have been collecting data which suggest that there are similar gradients in the vas deferens and the fallopian tubes. We may perhaps be able later to state it as a law that the direction of transport of material in a tubular organ depends on gradients of rhythmicity, tone, irritability and metabolism. When we come to think of it, our experience with engineering and mechanics should have led us long ago to look for gradients in these muscular tubes. We know that water in a pipe follows gradients of gravity or of pumping pressure; electricity flows along gradients of voltage, the winds follow gradients of barometric pressure, etc.

GRADIENT IN THE INTESTINE

Now what evidence have we that there is a gradient in the gastro-intestinal tract? As far as rhythmicity goes the evidence is overwhelming. It is a simple thing to open an animal (rabbit) under salt solution and to demonstrate that the rate of rhythmic contraction varies from about 20 per minute in the duodenum to 10 per minute in the lower ileum. It is easy also to cut out short segments of the bowel and to show that their rate of rhythmic contraction continues to vary inversely as the distance from the pylorus. A similar gradient can be shown in strips of muscle excised from the wall of the stomach. The fastest rate is found in the strip from the lesser curvature near the cardia. It is harder to show the gradient in the colon, but that was to be expected. Remember that the large bowel is more sluggish than the small; it lets the contents lie in one place for long periods of time and waves can go in either direction over the cecum and ascending colon. Hence it is that the excised muscle is slow to start beating, its rate is slow; it tends to contract down into a hard knot and stay that way; and the gradient is poor and often reversed. In the small intestine of the rabbit and white rat the rhythmic gradient is so fixed, and so intimately "built into" the structure of the intestine that one can determine the oral and aboral ends of short excised segments by counting the rates at the two ends. It has been shown also that when sections of small intestine are cut, turned end for end and anastomosed again, they will transport liquids but not solids, because the original direction of peristalsis is maintained as long as the animal lives. This experiment shows that the gradient is basic and not the result of functional adaptation. Further evidence for that conclusion is found in the fact that it is just as marked in the fetal intestine, which has not yet functioned, as in the adult animal. The permanence of the gradient in the gut is to be expected from studies on the lower forms of life. The mouth of a frog is lined by epithelium covered with little cilia which wave in one direction. If a piece of this epithelium is cut out, turned through an angle of 180°, and grafted back again, the cilia continue to beat in their original direction, now contrary to that in the rest of the mouth. In some of the worms the so-called "polarization" is so perfect that if the animal is cut into a half-dozen pieces they will all crawl in the same direction towards the point where the head used to be.

Before leaving the topic of rhythmic contraction I must make it clear that in the intestine the rhythm of one segment rarely influences the rhythm of the adjacent ones. As you know, in the heart the region with the fastest rate sets the pace for all others, and the wave of excitation travels so rapidly that to the naked eye the mammalian heart appears to contract simultaneously all over. In the stomach, the area with the most rapid rate at the cardia sets the pace, and we can see the waves traveling slowly to the pylorus. In the small intestine each segment contracts at its own rate and only occasionally do we see what are called peristaltic rushes running any distance down the bowel. Although the duodenal muscle has the fastest rate it does not set the pace for the rest of the gut. I must emphasize this point because some writers in overlooking it, have theorized unwarrantably on the basis of some purely anatomical observations reported by Keith.

UNDERLYING BASIS OF THE RHYTHMIC GRADIENT

The next question is: how are these differences in rate brought about? What are they due to? What are the structural differences behind them? As we have seen that these rhythmic movements are myogenic in origin, it is plain that we must look for the differences in the muscle. Now, it has been shown that the rate of rhythmic contraction is probably dependent upon the rate at which the chemical processes go on. Some substance is built up to a certain point and then exploded to produce the contraction. If the metabolism is slow it should take longer to complete the cycle. We know also that warming hastens chemical processes, and Taylor and I have shown that warming the intestine hastens the rate of rhythmic contraction. As we can take a piece of ileum beating 10 times a minute, and by warming it speed up its metabolism so that it will beat 17 times per minute, it seems to me that the duodenum which normally beats 17 times per minute must have a faster metabolic rate than the ileum. Such differences in metabolic rate have been demonstrated in other organs of the body, where they appear to have great significance.[12] During the last few years Miss Starkweather and I have brought forward a good deal of evidence to show that there is a gradient of oxidation from the cardia to the pylorus, from the duodenum to the ileum and from the ileocecal sphincter to the anus.[13] For the unit of weight and time the muscle from the duodenum gives off more CO_2 than does the muscle from the ileum. This is true not only for the active but also for the resting muscle. Graded differences have been found, moreover, in the catalase content of equal weights of minced muscle. This catalase, which liberates oxygen from hydrogen peroxid, is supposed by some to be an index of the rate of metabolism; and certainly in the bowel the gradients of CO_2 production and catalase activity run very close together. Be that as it may, the interesting thing to me is that we can show a definite chemical difference between the muscle in the duodenum and that in the ileum.[1]

We know that there is some gradation also in the irritability of the intestine as regards distension. The duodenum and jejunum are very responsive to the presence of food or balloons, while the lower ileum and colon are quite tolerant of them. You all know that the barium meal in the jejunum appears in small flecks as if it had been sprayed over the folds of the mucous membrane. In the ileum it forms dense sausage-shaped masses. That is due simply to the greater irritability and activity of the upper bowel.

Hess showed years ago that the pull exerted by the jejunum of a dog on a small balloon is 228 gm., while in the ileum it is 75 gm. Naturally, the food is going to move from the active and irritable regions to the more sluggish and insensitive ones. I cannot conceive of a simpler theory of peristalsis, or one more in harmony with the laws of physics and mechanics.

DIFFERENCES IN PERISTALSIS IN DIFFERENT PARTS OF THE GUT

Let us follow for a few moments the progress of a barium meal through the digestive tract, noting how the peristaltic movements are influenced by local differences in structure and musculature. The mouthful shoots through the first part of the esophagus because the muscle is quick-acting and striated. In the lower third the muscle is largely of the smooth variety and progress slows up. In the stomach the waves begin probably in the pacemaking region near the cardia and travel as shallow ripples until either proper pressure conditions or the presence of the peculiar antral muscle causes them to break into deep waves. If the tone of the stomach is too high the waves may be very shallow or hard to see; if the tone is poor, we may see the best waves at the beginning of the examination when there is only a little food present and the muscle fibers are not too badly stretched.

The waves do not cross the pylorus, probably because of the connective tissue barrier there, the peculiar arrangement of the muscle fibers, and the sudden transition to a different type of muscle. The control of the pylorus is partly chemical and partly mechanical. Cannon has shown that the presence of acid above tends to relax the sphincter and acid below tends to close it. We know however that this mechanism will not explain the vagaries of pyloric action in achylia gastrica, in duodenal ulcer, carcinoma, etc. We know also that the mere presence of food or of a distending balloon in the duodenum and jejunum will tend to stop the progress of food through the pylorus.[14] It is this mechanism that keeps the stomach from emptying too rapidly after pylorectomies, Mayo-Polya operations and gastro-enterostomies. This holding back above an active or distended part of the gut is easily explained on the basis of changes in the gradient. The digesting, stretched bowel has a faster metabolic rate and a more rapid rate of rhythmic contraction; hence the gradient is likely to be uphill towards it. This will tend to slow the progress of more food coming down from above.[15]

The duodenal cap remains filled and shows almost no peristalsis, probably because the muscle removed from that region shows very little rhythmicity. There is some evidence that the muscle fibers are arranged in festoons and not circularly and longitudinally, as they are elsewhere. This might also tend to modify the contractions. I think the peculiarities of the upper duodenal regions, together with a number of its pathological tendencies, can be traced back to the great specialization and complexity of this part of the bowel in some of the fishes.

As I have already stated, the jejunum is jejune or empty because of its great irritability and rapid peristaltic rate. The food slows up in the terminal ileum because the muscle is more sluggish and because the gradient is uphill for a short distance to the ileocecal sphincter.

In the first third of the colon the gradient is poor, so that the waves can go in either direction. In the rat they tend to be antiperistaltic when the feces are liquid and peristaltic when the feces become drier. The colonic contents move slowly because the muscle is more sluggish and perhaps because the gradient is poor. The tendency for the feces to stay out of the rectum can be explained if I am right in thinking that the gradient is uphill in that region. There is some evidence from animal experimentation in favor of that assumption.[16]

PRACTICAL VALUE OF THE GRADIENT THEORY

This idea of a gradient underlying peristalsis gives us facile explanations for many of the phenomena observed in disease. The gradient of forces can be steepened, flattened or reversed. A duodenal ulcer which raises the irritability and tone of the upper end of the tract often hurries the progress of food through the small intestine; a lesion in the appendix or cecum which raises the irritability of the lower end of the bowel slows the current and produces ileal stasis. A fissure in the rectum may cause back pressure into the cecum with constipation. A patch of enteritis in the jejunum can reverse the current above, in the duodenum and stomach—with vomiting; and can hurry it below—with diarrhoea. A stimulus reaching the jejunum from the brain by way of the vagi—as in sea-sickness—may also empty the tract both ways. The distension of any part of the tract by food raises the tone and irritability of that region and tends to hold back the material coming down from above.

Theoretically, the gradient can be reversed not only by raising the lower end, but by depressing the upper end. My observations on excised segments of intestine from distempered dogs and snuffling cats agree closely with those of Child on the lower forms of life in showing that the most sensitive regions, which have the fastest metabolic rates and the greatest need for oxygen, are injured most by asphyxia, by many drugs and by disease toxins. I have shown repeatedly that a poison can be administered in such dosage as to have no effect on the colon and ileum, while it paralyzes the duodenum and weakens the jejunum. Furthermore, exised segments of duodenum from a sickly rabbit may not contract at all in Locke's solution when similar segments from the ileum of that animal show no sign of toxic influence. A reversal or a flattening of the chemical gradients can also be shown in many of the sick animals. We have here, then, an easy and very simple explanation for the digestive upsets with intestinal stasis which we see in fevers and asthenic states.

As I have discussed the practical aspects of my theory in previous papers[17] I will not go into the subject any further at this time. Remember, when confronted by an abnormality in intestinal peristalsis, that if the lesion is sufficiently irritating it will raise the local tone; this will reverse the gradient leading to the lesion on the orad side and it will steepen the gradient on the caudad side. Hence it is that it may slow, stop or reverse the progress of material coming toward it from above, and may hasten the progress of material that has passed it. Exceptions to this rule will be found around the stomach where there are many complicating factors not sufficiently understood at present.

In closing, I must admit that with all the work that has been done we still know too little about the origin of many of the disturbances of function which we see in our patients—the hypo- and hypermotilities, the sphincter spasms and the peculiarities in gastric peristalsis. We must keep in mind that we are using a physiologic method, borrowed from Cannon; we must think more in terms of deranged physiology, and must not rest too satisfied with the demonstration of beautiful morphologic defects—ulcer craters, carcinomas, adhesions and displacements. A number of you—practising radiographers—have made excellent physiologic studies on man; studies that are as much pure physiology as those of Cannon and Carlson. Much remains to be done; and if my little message from the biologists to-day should contribute anything to your zeal and skill in attacking these problems I shall be happy.

SUMMARY

We often fail in trying to solve our practical problems because we do not begin near enough to the beginning. We must know more about general principles and the workings of small parts of the digestive tube.

We must venture out more into "pure" science. We can get much help and inspiration from the experimental zoologists and the physiologists.

The digestive tract is largely autonomous, and the forces underlying peristalsis must be looked for mainly within the gut itself.

The tendency of writers to explain everything on the basis of nervous reflexes and ganglionic control is unfortunate, and paralyzing to further progress.

Recent biologic work has shown in numberless ways that the main function of the nervous system is conduction.

It has been shown conclusively that the rhythmical contractions of the intestinal muscle are myogenic in origin.

Auerbach's plexus serves to conduct stimuli and to coordinate the activities of different parts of the tract. It contains no reflex arcs.

Current theories about the antagonism between the vagus and sympathetic are shown to be pseudoscientific, and out of harmony with the facts as determined by the leading anatomists and physiologists of the world to-day. The sympathetic is an integral part of the central nervous system and not an outlying antagonistic "brain."

Many of the conclusions based upon the supposed actions of drugs on nerve-endings and "intermediate substances" must be revised in the light of recent work.

The extrinsic nerves of the intestine serve to communicate between the body and the bowel, and between the bowel and the brain.

The digestive tract can work quite normally after section of all the extrinsic nerves.

The key to an understanding of peristalsis is to be found in a study of the smooth muscle in the wall of the bowel.

There are different types of muscle suited to different functions in the different parts of the body and in different parts of the digestive tract.

The properties of smooth muscle are discussed: its reactions to stimulation, to distension, inflammation, etc.

A peristaltic wave spreads both ways from a stimulated spot like ripples from a stone thrown into a pond. Most of the muscular tubes are so constructed that the ripples can travel in one direction better than another.

It may perhaps be a law for all tubular organs that the transport of material in one direction depends upon gradients of rhythmicity, irritability, tone and metabolism.

Such gradients can easily be demonstrated in the walls of the stomach and intestine.

A bolus moves aborally in the digestive tract because the pressure is greater on the upper than on the lower side. This difference in pressure is due probably to the graded characteristics of the muscle.

The peculiarities of peristalsis in different parts of the tract are explainable on the basis of local differences in the structure of the neuromuscular mechanism.

It is shown how the gradients may be upset in disease, and how these theories can explain pathologic phenomena.

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PNEUMOPERITONEUM OF THE PELVIS*

GYNECOLOGICAL STUDIES—A PRELIMINARY REPORT

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AND

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A VERY fortunate and brilliant stereo set of the pelvis in a case coming from another ward was the means of interesting Dr. Reuben Peterson, Professor of Obstetrics and Gynecology at the University Hospital, in this study, and it is due largely to his hearty and enthusiastic cooperation that work was undertaken on this subject and the present series of cases made possible. He immediately suggested the possibilities of this method for the illustration of clinical lectures and the study of the anatomical relationship of the normal and pathological pelvis, quite aside from the possibility of the development of any diagnostic value. As a further piece of good fortune, one of the earliest cases provided such illuminating evidence, even though it was poorly understood at the time,that a serious attempt to develop the diagnostic feature of the method was projected.

At the outset it was agreed that if the method were to have any extended usefulness the technique must be at once safe, simple, certain and cheap; and throughout we have aimed to produce a method and a procedure which can be reduced to a routine and can be carried out by the assistants in the Department of Gynecology and the lay members of the radiographic staff. Naturally, our first efforts were far from simple and still farther from certain. In the interest of safety, Dr. Peterson agreed to attend personally to the inflations during the developmental stage, and to date we have examined somewhat over forty cases without any unexpected or disagreeable complications.

At the present time we have tentatively adopted the following procedure: The patients are inflated in the examining room in the Department of Gynecology immediately at the conclusion of the regular gynecological examination and on the regular gynecological table. The inflation is preceded by an injection of Schleich's solution and the point selected for puncture is usually about one inch below the umbilicus in the median line, unless previous operative scars, evidence of adhesions, or other pathology, contra-indicate.

Carbon dioxide is taken from one of the usual commercial tanks from which a nitrous oxide bag is filled, and this bag is then connected with the needle without intervening manometers or washing or sterilizing apparatus. During inflation, the bag is held between the knees of an assistant, thereby giving complete control over the pressure as well as giving a fair indication of the amount of gas which has been injected. We have found that from 1½ to 2 liters of gas are sufficient to produce a fair inflation of the pelvis, although in certain individuals the bowel coils can still be seen resting on the anterior abdominal wall in the most dependent portion of the belly.

The patient is then turned over on the face, being held in the knee-chest position until an inclined board can be placed beneath the thighs. This board makes an angle of about 28 degrees with the plane of the table and its upper portion is cut out and rounded so that the pubis comes to lie just about the deepest portion of the notch. An 18 inch square of opaque fabric with a 6½ inch circular hole cut out of its center is laid on the buttocks and serves as a diaghragm. A plate changing tunnel is then placed horizontally on the table, double screen films are used, and a Coolidge portable unit, operating on the ordinary lamp circuit, furnishes the *x*-ray. An exposure of from fourteen to twenty seconds is required, and ordinarily each exposure is interrupted, being made at such intervals as the breath can be held conveniently, and the patient allowed to breath between the fractional exposures.

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The tube shift is in the long axis of the body and the stereo set so produced is used as though the patient were lying on the right side.

This technique is the result of a series of progressive improvements. For instance, at first we used oxygen and brought the patients down to the *x*-ray room where they were first "screened" and then "plated." This method was entirely satisfactory from the *x*-ray point of view, but there was considerable complaint on the part of the patient for twenty-four or forty-eight hours if they attempted to move from the rigidly dorsal decubitus. Consequently a similar procedure was attempted with carbon dioxide; but it was found that if there were any unusual delay in the transportation of the patient—over several floors and down at least two elevators—the amount of gas remaining in the peritoneal cavity was insufficient to secure satisfactory plates. The portable *x*-ray machine used in the gynecological examining room seems to be a perfectly satisfactory solution of this difficulty.

We have also found that not so large an amount of gas is necessary for the inflation of the pelvis as for a satisfactory examination of the abdomen as a whole. Provided the examination can be undertaken immediately, we now believe that from a liter to a liter and a half is sufficient to inflate a pelvis of ordinary size. However, in order to be certain that all the intestines which normally lie in the pelvis may have a chance to escape, we prefer to give two liters of gas wherever the patient does not complain too seriously.

In the earlier cases there was considerable complaint, on the part of the patients, of persistence of the pain and discomfort for twenty-four to forty-eight hours. Accordingly, deflation was practiced. Since the introduction of carbon dioxide, deflation has not been necessary, and patients inflated at about 11 o'clock in the morning have taken their noonday meal in the sitting posture with complete comfort and no more reports of sleepless nights have been encountered. This is undoubtedly due to two factors: first, the more rapid absorption of carbon dioxide; and, second, to the smaller quantity of the gas introduced in the later cases. While discomfort and a sense of oppression are a constant complaint, these are not important except in cases with serious pathology in the upper abdomen or (as we suspect) with adhesions to the parietal peritoneum in the abdomen or pelvis.

For a time we introduced a short narrow helix of wire into the vagina for the purpose of simplifying the recognition of the various shadows in the pelvis by reason of the better differentiation which would result from a demonstration of the axis of this cavity. The shadow of the fundus of the uterus which in the earlier experiments was apt to be hidden in the shadow of the bladder, was thereby thrown backwards and more nearly into the axis of the pelvis and was more clearly outlined. However, because of the distortion which was introduced by the inflation of the vagina and the bulging of the posterior vaginal wall into the cul-de-sac of Douglas—almost invariably to one side of the median line—and because of the resulting distortion of the position of the uterus, this procedure has been discontinued.

It is probably superfluous to speak here of the advantages of the stereo set. However it is well to realize that the stereo effect in pelxis *x*-rays is not nearly so perfect as it is in the study of the bones or of the chest. The appreciation of depth is only possible when a definite point or a series of points is presented to the eye, establishing a definite parallax. In the case of a smoothly rounded soft tissue body of uniform density, such as we are dealing with in the pelvis, such points are not normally found. The only lines upon which the eye can fix are the shadows of those portions of the perimeters of such bodies which are projected by rays which are tangent to the surface at these points. The depth of the fundus of the uterus appears, therefore, to lie in the position of its equator, and one gets no impression of the extent or the position of that organ above or below that point. The image of an irregular body will be represented by a series of "optical cross sections" at the point of tangency of the projecting rays. For instance, the image of the uterus, four months pregnant, is represented only by the cross section of its enlarged cervical or supracervical portion (the isthmus) and by the shadow of the anterior surface of the neck just behind the pubis where it curves upward and extends into the abdominal cavity, while the upper margin of the body of the uterus is lost in the diffuse shadows of the abdomen. Our appreciation of the contour of this body is accordingly somewhat fragmentary and our conception of its shape may be quite erroneous. Nevertheless we believe the stereo set to be well worth while because of the ease with which the rather complex shadows of the pelvis may be resolved, the extraneous shadows excluded, and the relative position of these cross sections appreciated.

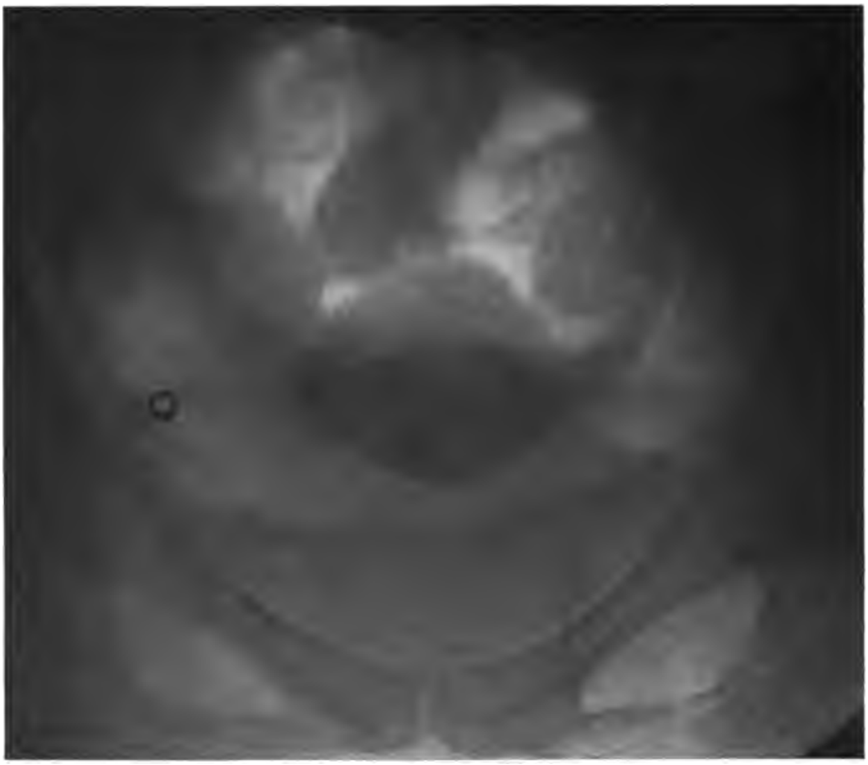

FIG. 1. NORMAL PELVIS. Note the optical cross sections of the isthmus and fundus of the uterus.

Our experience is obviously too limited to give an exhaustive exposition of the significance of the shadows seen. We have, however, tentatively reached certain conclusions which may be of value in the further study of this branch of roentgenographic work.

It appears that the normal pelvis is rather easily and regularly freed of all intestinal coils with the exception of that portion of the pelvic colon and the rectum which have no mesentery; and that this may be accomplished with a comparatively small amount of gas. The shadow of the rectum is closely applied to the anterior surface of the sacrum, and as it is projected well above the shadows of the female generative system, it offers no confusion if the technique advocated is followed. It makes little or no difference whether it be full or empty. Even barium-containing feces serve only to fix the position or facilitate the orientation of the image.

Whether this rule of the mobility of the pelvic intestinal coils is so invariable as to justify the conclusion that the presence of such shadows is an evidence of pathological adhesions, remains in doubt and obviously will always remain dependent upon the care exercised in the details of the technique and, in particular, upon the quantity of the gas injected. With the exception of a few cases in which the inflation obviously was insufficient, that conclusion seems to be justified by our experiences.

If a perfect degree of elevation of the hips has been attained and the direction of the ray is in the long axis of the pelvis, both the anterior and posterior pelvic pouches are empty of everything but gas. In the presence of pathology, either the one or the other may be filled with inflammatory exudate or adhesions, or incarcerated bowels and omentum, with consecutive displacement of the uterus and the broad ligaments which form the transverse partitions of this portion of the pelvis. Such displacement with obliteration of either of the pouches is one of the most striking features of inflammatory disease of the pelvis.

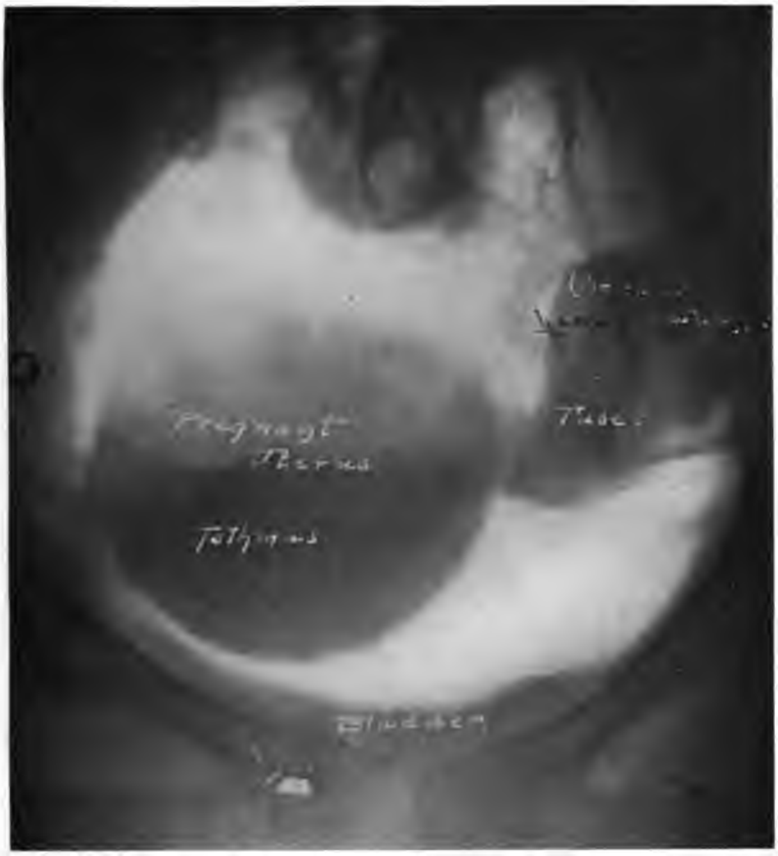

FIG. 2. PREGNANCY AT SIX WEEKS. Mass on the left, possibly the ovary, with corpus luteum vera.

When entirely empty, the bladder shadow is scarcely recognized on the posterior surface of the pubic bone. When distended, however, it may be seen as a rounded shadow of no very great saliency exactly where one would expect to find it, and its recognition is never a matter of great doubt.

The fundus of the uterus in a properly placed patient is separated from the bladder shadow by the space of the anterior or utero-vesical pouch which normally contains gas. In the presence of a marked relaxation of the pelvic floor, or where the position is not satisfactory, it may be found to lie on the posterior surface of the bladder and may be exceedingly difficult to recognize. This is particularly true in cases of senile atrophy. The introduction of a helix of wire into the vagina with the resulting dilatation of this cavity seems to help to throw this shadow backwards, more nearly into the axis of the pelvis. Our experience appears to show, however, that the same result may be accomplished by a slightly greater elevation of the hips and a little more care in directing the ray.

On either side of the uterine shadows are seen the narrow linear shadows of the broad ligaments clearly spreading out at either end, centrally embracing the uterine shadow and peripherally fusing with the pelvic wall. Where the uterus is displaced or distorted, these broad ligament shadows serve to direct one to the position of this organ. It appears that they are best seen at a level somewhat above that of the cervix, but well below the equator of the fundus.

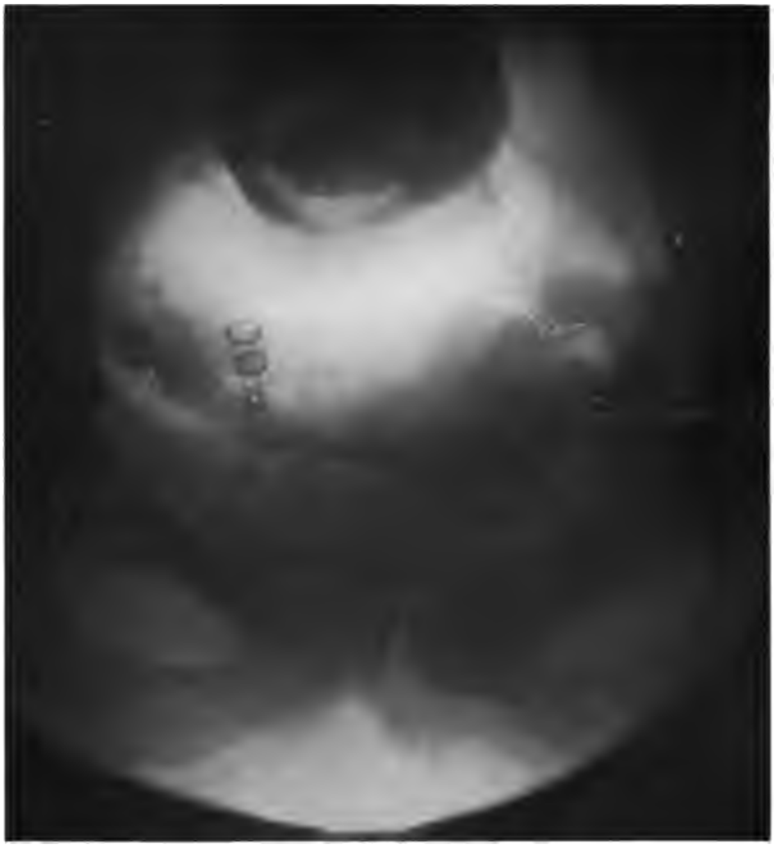

FIG. 3. UNILATERAL DISEASE OF THE TUBE. AT OPERATION CONTAINED PUS.

We have never, to our knowledge, recognized the round ligaments and greatly question whether they would ever appear on the plate. We have once or twice imagined we could see them, but operation proved that they lay in quite a different position. Careful examination of the opened pelvis gives us no reason to suppose that these exceedingly tenuous structures with their thin enveloping layers of peritoneum could reasonably be expected to show in the relatively large mass of tissues which the ordinary female pelvis presents.

The normal tubes are not seen as a separate or recognizable shadow. They apparently are component parts of the broad ligament shadows. When distended or inflamed, however, they become conspicuous as tortuous shadows on the posterior surface of the broad ligament shadows, possibly obliterating them by overriding, or as pear-shaped shadows in the postero-lateral portions of the pelvis. In chronic cases the picture may be much confused by the overlying (adherent?) intestinal coils. The distortion produced may make it difficult to recognize the shadow of the uterus and almost invariably the posterior cul-de-sac is much contracted and encroached upon by what appears to be inflammatory tissue and cicatrix.

The normal ovaries apparently are not seen. They probably lie on the postero-lateral aspect of the uterus slightly below the equator so that they form an integral part of the uterine shadow. Their position is exceedingly difficult to verify from the fact that the operation is invariably undertaken in the Trendelenburg position, while the roentgenogram is made in precisely the reverse, namely, the knee-chest position, and the effect of gravity would be to carry the ovaries upward rather than downward and backward. A curious observation is that the ovarian shadows are very conspicuous and easily recognized in cases of retroversion and "prolapse of the appendages," evidently being carried backward by the pathological shortening of the utero-ovarian ligaments. It is also worthy of note that a refractory retroverted uterus which cannot be replaced by ordinary manipulation appears to effect a

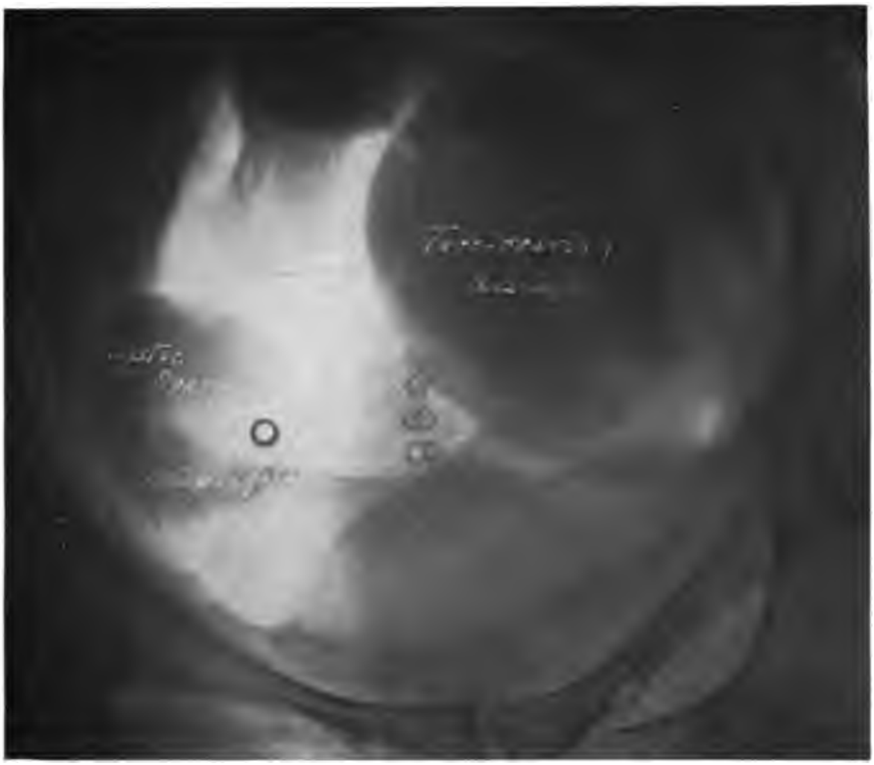

Fig. 4. Bilateral Tubal and Ovarian Disease.

spontaneous reduction and is represented by an enlarged fundus almost in the axis of the pelvis and flanked on either side and posteriorly by the conspicuous ovaries closely applied to its postero-lateral aspect.

Ovaries containing small cysts have been found and recognized as ovaries although the cystic element was not recognized. Larger ovarian cysts produce a variable picture that will leave one rarely in doubt. Considerable distortion may result, as in the specific case of a young girl with a pendulous cystic ovary which hung apparently almost in the exact axis of the uterus so that the differentiation of its shadow was impossible in the imperfect state of our knowledge at that time. The unusual mobility of this cystic ovary was clearly demonstrated at operation.

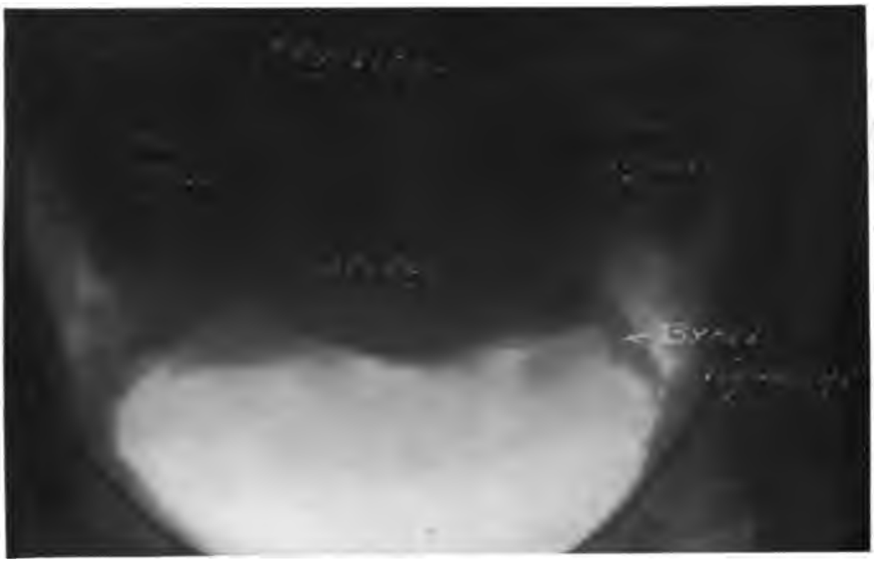

Fig. 5. Chronic Pelvic Inflammation. Note the obliteration by adhesions of the posterior cul-de-sac and the distortion of the broad ligaments.

The cervix and the vagina, as well as all structures in the pelvic floor which lie below the level of the peritoneal pouches behind the broad ligament, are entirely undifferentiated, and it is entirely probable that considerable infiltration of the soft tissues in this neighborhood will leave no recognizable evidence. The insertion of a helix into the vagina serves to fix the position of this cavity and the direction of its axis; but pathology in this neighborhood, such as carcinoma of the cervix, may be expected to escape detection entirely except in so far as it encroaches upon the structures above the deepest portions of the cul-de-sac.

Enlargements and tumors of the pelvic organs cast conspicuous shadows and often rise into the abdomen. We are not yet ready to formulate any comprehensive set of rules for their differentiation, because of the paucity of our data. We tentatively offer the observation that the pregnant uterus casts a shadow less dense than myomata. One gets the impression of a high degree of elasticity, and the enlargement of the isthmus, or supracervical portion, of the uterus as seen in cross section, as well as the broadening of the broad ligaments, is more conspicuous in pregnancy than with tumors. Incidentally the shadow of the fundus of the uterus is not differentiated once it is out of the true pelvis, although its anterior surface at the plane of its inflection can sometimes be seen immediately behind the pubic bone. In fibroid of the uterus, on the other hand, the cross section of the isthmus is not enlarged, the mass has considerably greater density, and does not appear to be flattened out as in the case of the pregnant uterus.

It would be an obvious error to attach any great weight or authority to the above hasty generalizations on so few observed cases. We have found that a diagnosis is anything but easy, and continue to meet with a discouraging number of disappointments. The findings, however, are so striking and the stereoscopic picture so intriguing that we cannot refuse to entertain the hope that reliable criteria of interpretation will be developed by a continuation of these studies. Both Dr. Peterson and myself are planning later communications on the results of this work as soon as reliable conclusions seem justified.

Even though the method can be developed to the point where a reliable judgment is possible on the part of the roentgenologist, it is not at all certain that his opinion will be of material diagnostic assistance to the gynecologist, since he, the gynecologist, is already fairly competent to reach a satisfactory conclusion by bimanual palpation. However, several instances in which interesting, if not essential, information was obtained, seem to warrant the expectation that the method will find a legitimate application in selected cases and furnish a common interest with still another specialized branch of modern surgery with which we, as roentgenologists, have heretofore found few points of contact.

[Note. The discussion of this and other papers relating to Artificial Pneumoperitoneum presented at the Twenty-first Annual Meeting will follow the publication of the entire series.]

THE TREATMENT OF CARCINOMA OF THE BREAST BY IMBEDDING RADIUM SUPPLEMENTED BY X-RAY*

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IN all the progress made in recent years in radiotherapy, nothing has been evolved of such significant import in the treatment of carcinoma of the breast, as the advanced method of imbedding radium, with its manifold and varied advantages and possibilities in deep therapy. By imbedding radium throughout the entire breast, in the axilla, into the glands leading from the breast to the axilla and into the glands below the clavicle, it is now possible to make radiation for carcinoma of the breast as thorough as a radical dissection without opening the lymph channels. Supplementing Coolidge *x*-ray treatment to the twenty or more lymphatic chains draining the breast, using 10 mm. of aluminum and cross-firing as much as possible, there is completed the most advanced and most effective treatment, which is in marked contrast to the treatment given fifteen or twenty years ago with a comparatively low penetrating gas tube, using no filtration or meters for giving exact dosage, and thus administering only superficial radiation when deep treatment was necessary.

In the early days of radiotherapy a deep lethal dose could not be given without producing superficial ulceration or necrosis. By imbedding radium a lethal dose can be given without any effect on the skin. Besides the subcutaneous tissue will tolerate from three to five times as much radiation as the skin. The result of radium in malignancy depends upon whether a lethal dose is given. Formerly it was concluded, because our best radiograms were taken with comparatively low tubes, that this form of radiant energy was the most suitable for deep therapy. Almost every one overlooked the loss of energy by absorption in the tissues and by divergence of the rays, and practically nothing was known about the lethal dose of different types of malignant cells. Most radiologists compared everything with the amount of radiant energy necessary to destroy rodent ulcer; and when the squamous cell epithelioma, axillary nodes and a cancerous mass in the breast did not disappear under *x*-ray, the radiation was considered useless. The real fact was that a lethal dose had not been given.

Radiation for the treatment of carcinoma of the breast has been so changed by imbedding radium that where only superficial skin effects were formerly produced, now cancerous tissue deeper than that which can be removed by the knife can be destroyed without opening the lymphatic chains. Before imbedding radium I always give surface applications in the axilla and over the glands below the clavicle, and I give a complete course of heavy filtered *x*-ray treatment to the breast and all the glands draining it. This checks cell proliferation and lessens the danger of metastases when the breast and adjacent lymphatics are speared and radium inserted. It is generally agreed that it requires from two to four weeks to check cell proliferation. It has been shown that the lymphatics begin to undergo a fibrosis at the end of the fourth week and that the caliber of the lymphatic vessels are smaller than before treatment was given. It seems just as advisable to give surface treatment before imbedding radium as before operation. Some few surgeons are now advising ante-operative treatment, and if they would include imbedding radium and remove less tissue, thereby leaving the sclerosed lymphatic tissue as a barrier against cancer cells, I feel sure that the end results would be better, at least in borderline cases; that is, there would be fewer recurrences, and if a recurrence did take place it would be considerably later than when the operation precedes radiation.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

Imbedding radium in the treatment of carcinoma of the breast is a step in advance, but the number of cases treated by this method are not sufficient and its use is of too short duration to speak about anything but temporary results. Even in some of the advanced cases the disease in the breast and the glands appears to have retrogressed, clinically. Of course in some cases there is still thickening due to the fibrosis from the radiation. Not enough cases have been operated upon to give definite histological changes. In the inoperable cases we were inclined to leave well enough alone, and in the early cases each one has refused operation. My advice has been, even in the advanced cases, where the disease has clinically receded, to have the breast removed without opening the axilla; but to my extreme disappointment, in almost every advanced case that I turned over to the surgeon he opened the axilla, and when the patient returned, almost without exception she had a swollen arm and was in much worse condition than before operation. I feel sure, however, that if we could have the surgeon remove only the breast, thereby taking away the unhealthy mammary gland, the patient would be greatly benefited. I am speaking of the advanced or inoperable cases which have had thorough radiation, and not the early cases which we are advising to have ante-operative radiation. Imbedding radium as described takes the place of operation in advanced cases, and as before stated, the removal of the breast is all that is advised.

It is imperative that every therapeutist should make a comprehensive study of the lymphatics draining the breast before he attempts to treat mammary carcinoma. The lymphatic supply to the breast is greater than to almost any other organ of the body. A study of the lymphatic and bone metastases will show that although the case is operated on early, the raying of the line of incision, axilla and supraclavicular region is very incomplete.

Deaver's classification in regard to end results are probably as near correct as that of any other author and should be studied by the surgeon and radiotherapeutist. He says: "It has been stated that 80 per cent of patients in whom the disease is confined to the breast, as proved by both microscopic and macroscopic examination of the tissues adjacent to this organ, are permanently cured of their disease by the radical operation. Therefore, a patient presenting a small movable mass localized.in the breast can be assured that four out of five cases of a similar nature are cured by operation. When axillary lymph nodes are palpably enlarged as the result of metastases, the chances of operative cure are at once diminished to one in five."

This deduction is practically the same as that of Halstead, who says that, notwithstanding the present day extensive operation, death from metastases occurred in 23.4 per cent, even in cases with a microscopic negative axilla. Deaver questions whether as much palliation is received from operative as from non-operative methods, and expresses his general dissatisfaction with operation of a palliative nature in the treatment of carcinoma of the breast, since in certain cases the disease has been excited to greater activity by an incomplete operation, and the life of the patient considerably shortened.

In this connection he mentions the unreserved statement of Bloodgood, "that incomplete operation hastens death."

The above quotation which is taken from Deaver's carefully prepared volume, "The Breast, its Anomalies, its Diseases and their Treatment," should receive more attention from the medical profession.

The prognosis and treatment of mammary carcinoma can be estimated only after consideration of many factors. Hanley considers operation contra-indicated when there is extensive ulceration and when the tumor is adherent to the chest wall; when axillary nodes are flexed; when there is supraclavicular involvement and when there is indication of distant metastases. When the axillary glands are palpable there are very few cures by surgery alone without radiation, even when the axillary nodes are not palpable; and when the glands are found to contain cancer cells microscopically only about 20 per cent of the cases are cured at the end of five years. Greenough claims that when the axillary nodes are palpable, 12 per cent were cured by operation, and Finsterer stated 4.3 per cent. Ewing believes the latter represents the average success by surgery, which means that a woman who has a well established cancer of the breast, with palpable axillary nodes, has one chance in twenty-five of being cured by operation. Therefore, in cases of this class it is not too much to advise imbedding radium and giving a thorough course of radiation before the removal of the breast.

The clinical and pathological studies of cancer of the breast have shown that both surgery and radiotherapy meet with many difficulties and uncertainties. The anatomical types are so many, the variations of the clinical course are so wide, the paths of dissemination so diverse and the difficulty of determining the actual condition so complex, that giving a lethal dosage is difficult. Since Deaver and Bloodgood both claim that an incomplete operation hastens death, there is good reason for advocating the imbedding of radium into the breast and into the adjacent lymphatics wherever possible. A study of autopsies shows that almost any organ of the body may metastasize from cancer of the breast, and however closely confined to the superficial tissues the growth seems to be, no one can tell where the cancer-growing edge may extend; although unappreciable by ordinary methods of examination, it is just as definite as ringworm. This shows us that even in the early cases no lymphatic chain should be omitted when raying the lymphatics with a Coolidge *x*-ray tube, and as much cross-firing should be used as possible. In an article which I read before this society in 1917, I described the glandular distribution of the breast and the method of raying with a Coolidge *x*-ray tube. Since then I have been using 10 mm. of aluminum, giving from fifteen to twenty minutes' exposure. At that time I made the statement that "we are all looking for some means by which the skin will tolerate larger doses." This has to a certain degree been accomplished by imbedding radium and using heavier filtered *x*-rays.

After cancer cells have reached the axillary nodes, the disease soon becomes generalized, and tissue in almost any part of the body may become involved. If we had an *x*-ray microscope and it were possible to give a lethal dose to all cancer cells, the end result would be different. When it is impossible to give a lethal dose, palliation and prolongation of life is obtained in nearly all cases. Less than a lethal dose will usually stop cell proliferation, produce a fibrosis of the lymphatics and obstruct or obliterate the lymphatic vessels, thereby checking cancer dissemination. In fact, radiation changes the character of the disease, transforming it into more of a scirrhus form, by decreasing glandular cells and increasing the fibrous stroma. This mechanical choking clinically seems to influence the constitutional resistance of a patient. The same difficulty is not encountered in giving a lethal dose when radium is imbedded in cancerous tissue as when deep seated metastases are treated either by surface applications of radium or *x*-ray.

In calculating the filtration and the number of ports of entry or the amount of cross-firing necessary to give a lethal dose to metastatic lymphatic glands, it is necessary not only to know the anatomical situation, but we must know the depth and density of the overlying structures. It makes quite a difference whether the glands are situated one-half inch or four inches from the surface. The erythema dose in carcinoma of the breast is very seldom the lethal dose. The lethal dose is from three to six times the amount of the erythema dose. Therefore, if a surface erythema dose is given and the disease is four inches below the surface of the skin, the loss of radiant energy by divergence of the rays and absorption of the tissues with an *x*-ray tube placed eight inches from the surface with the equation used, is about one-ninth; or in other words, only about one-ninth of the surface radiation reaches four inches below the surface of the skin. Then if the lethal dose is from three to six times the erythema dose, it can be readily seen that when only one port of entry is used the treatment would be useless. Formerly, too many were satisfied with the removal of the visible part of the disease. The degree of malignancy is no guide to the amount of radiation determining its lethal dose. On account of rodent ulcer growing slowly and responding to small amounts of radiation, these circumstances led many to believe that a lethal dose was determined by the degree of malignancy of a tumor. Medullary carcinoma may respond more readily to radiation than the scirrhus type, but it grows more rapidly and invades the glands early, so if a cure or even an inhibitory effect of the disease of this type takes place, both the local tumor and metastases must be given sufficient radiation. If results are going to be produced in the medullary type, the cancer cells must show effect within three or four weeks, and fibrous tissue must be forming at the end of this time. In the scirrhus type, the fibroid formation has already taken place by nature's process.

When we speak of the lethal dose of radiation, we refer to direct action on malignant tissue; but there is an indirect effect of radiation on malignant cells by the formation of fibrosis which starts to form three or four weeks later. Both are important, and a lethal dose should be given whenever possible, but less than a lethal dose sickens the malignant tissue, as Mayo expresses it, and starts the formation of fibrous tissue which is a barrier against the disease. In locations where radium can be buried a lethal dose can nearly always be given, but in the treatment of deep metastatic glands we may be compelled to depend upon both the direct and indirect effect of radiation on malignant cells. Therefore, when carcinoma of the breast is so far advanced that a cure cannot be expected, the patient should have all the palliation possible from both the direct and indirect effects of radium and *x*-ray.

In a tumor that does not respond readily to radiation there is more necrosis and less absorption when a lethal dose is given. In two cases in which the mass in the breast was hard and of long duration, the growth was walled off, and when the breast was speared, broken-down non-offensive material came out through the trocar. This was due to heavy surface applications of radium. In each of these cases a clinical cure was obtained after imbedding radium, and the normal tissue was not injured in either case.

The ability to classify cases requires clinical experience and forms an important part of the training of the radiologist. The question of large dosage altering normal tissue after the reaction has disappeared is an important factor, and this alteration of tissues will not permit the normal tissue to bear so well a second, third or fourth exposure. The normal tissues are usually injured by a frequent repetition of the radiation, while the cancerous tissue, if any remains, may not retrogress in a proportional degree. In fact, the cancer cell and normal tissue may react in about the same degree, or there may be a reversal of the primary susceptibility. This shows the advantage of imbedding radium wherever possible after a maximum surface dosage has been given.

The method I have adopted is to give a thorough course of Coolidge *x*-ray treatment to all the glands draining the breast, using the following equation: 10 mm. aluminum, 8 inch tube distance, five milliamperes of current, nine inch spark-gap and from fifteen to twenty minutes' exposure. A constant voltage is difficult to obtain. The pastille erythema dose is very unreliable and is not as accurate as the milliampere dose, using the different types of transformers with a fluctuating voltage. Calculations based upon false assumptions have been very misleading, and in giving a lethal dose exact standards must be employed. In many of the cases the breast and axilla receive a maximum dose from radium packs before imbedding radium.

Two or four weeks after surface applications I have been imbedding 10 mg. radium needles (vanadium steel needles, thickness of wall .35), placing them 1 cm. apart, and giving from five to eight hours' exposure. In some cases this produced a slight inflammatory reaction, but in no case has necrosis taken place. I may say that I started over three years ago—most reluctantly—to imbed radium in more superficial lesions; I can now indorse this technique as presenting many points of advantage over surface application in the treatment of many forms of malignant lesions, but it will not take the place of the Coolidge *x*-ray tube in the treatment of distant and deep metastases.

[NOTE. The discussion of this and other papers relating to Therapy presented at the Twenty-first Annual Meeting will follow the publication of the entire series.]

DISLOCATION OF THE CARPAL SCAPHOID

By T. S. BONNEY, D.D.S

ABERDEEN, SOUTH DAKOTA

THERE is very little to be found in the literature relative to dislocations of the carpal bones except that the condition is very rare; and the following case seems worthy of report for that reason. I was privileged to make the *x*-ray plates of this case through the courtesy of Dr. C. E. McCauley of this city.

Mr. L. J., age twenty-one, suffered a fall from a horse on October 15th, striking on his right hand, and was seen by Dr. McCauley October 17th, at which time the *x*-ray examination of the wrist was made by myself.

The accompanying cuts show clearly the dislocation of the bone in question.

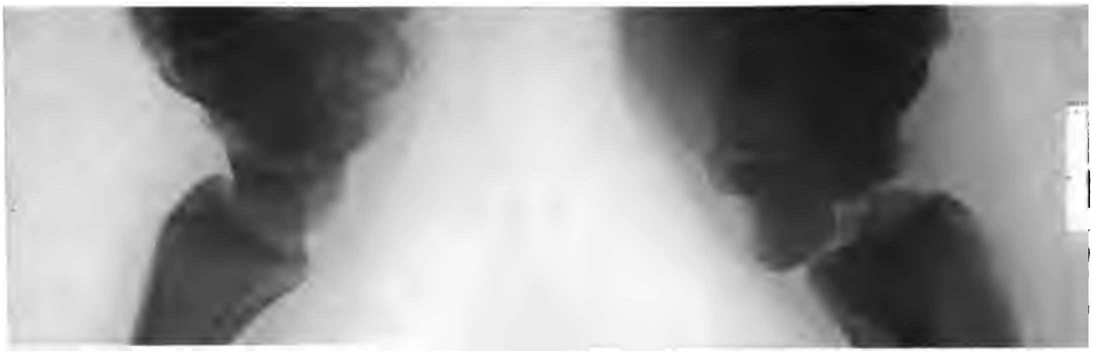

FIG. 1. SHOWING DISLOCATION OF THE RIGHT CARPAL SCAPHOID.

X-RAY TREATMENT OF TONSILS AND ADENOIDS

By W. D. WITHERBEE, M.D.

Radiotherapist, Presbyterian Hospital

NEW YORK CITY

FOLLOWING the suggestion of Dr. J. B. Murphy,[1] I treated the first case of hypertrophied tonsils in December, 1919, at the Rockefeller Institute for Medical Research.

This case, although carefully examined, revealed no changes in the surface size or outline of the tonsil, until the fifth week following treatment. The first evidence of the effect of *x*-ray was a smoothing out of the tonsillar mucous membrane, which very soon resulted in a glazed and somewhat pale surface.

This was followed by a rather rapid decrease in size, which in this case was most apparent in the left tonsil. At the end of eight weeks the left tonsil was seemingly reduced one half and the right one third.

About this time a dose similar to the first was given. Since then and up to the present time this patient has had no further trouble and the tonsils are apparently now both about one fourth the original size.

As soon as the effects on this case became conclusive Dr. S. L. Craig and I started a series of cases which numbered in all about sixty and ranged in age from sixteen months to fifty years.

In this series every patient was required to report for examination weekly. The history of each case was taken, a blood count made, the contents of the crypts plated and colonies of bacteria counted. A drawing of the throat and tonsils was made and notes were taken each time in regard to the progress of the case. Very few of these cases received more than one treatment, as we wished to determine the time necessary for the *x*-ray effects on the tonsil, and thus decide on the number of treatments required in a given case.

The amount of *x*-ray used in the experimental series of sixty cases varied from three to seven minutes time, depending on the age of the patient, with an 8 inch spark-gap, 5 milliamperes and 10 inches distance, filtered through 3 mm. of aluminum. This dose of filtered *x*-ray is less than the standard amount used for the past twenty years in the treatment of ringworm of the scalp in children, which fact overcomes the possible objection of any untoward effects on adjacent tissues from the standpoint both of amount, and of area of the head exposed.

In ringworm of the scalp five exposures are necessary in order to obtain uniform results of epilation. Only two exposures are necessary in each treatment of tonsils, and the maximum dose used is 1¾ skin units[3] of filtered ray, which corresponds to less than 1 skin unit used in temporary epilation of the scalp in children. It is generally conceded by most writers on this subject that the increased size of the tonsil depends directly upon the increase of the lymphatic tissue. The follicles appear larger than normal, are less sharply outlined, and usually the germinal centers are quite prominent and contain numerous mitotic figures. Occasionally the lymphoid cells appear to overflow into the interfollicular structures. According to Kellert[2] the hypertrophy of the follicles appears to cause distortion of the crypts, thus aiding in retention of the crypt contents.

The effect of *x*-ray on lymphoid tissue in the diseased tonsil is exemplified in the diagrammatic representation Figure 1. The destructive action of *x*-ray on the cells of the lymph follicles of both the lymphoid and fibroid tonsil are also well outlined.

The sections taken from an enlarged tonsil (Fig. 2) and the two made of tonsils enucleated eight weeks and four months after one massive dose of *x*-ray (Fig. 4) indicate the cause of the shrinkage of the tonsil and expulsion of crypt contents.

The selective action of *x*-rays on embryonic tissue or its effect on the cell in certain phases of mitosis are the usual methods of describing *x*-ray effects on diseased cells as compared with normal cells.

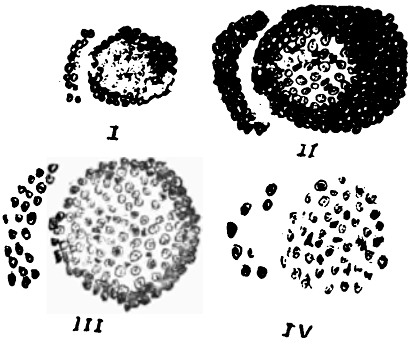

FIG. 1. I. Standard Lymph Follicle. II. Lymphoid Hypertrophy. III. Fibrous Hypertrophy. IV. Effects of *X*-Ray on Lymph Follicles.

The destructive action of *x*-rays on the cells of these enlarged lymph follicles might also be explained on the ground of their having been stimulated to excessive cell proliferation to such an extent that there remains less resistance to the *x*-ray than in the normal cell. Therefore this difference in resistance would account for the small dose of *x*-ray necessary to destroy these pathogenic lymph follicles without interfering in any way with the normal adjacent cells.

The bacteriological report embodied in the following table indicates the possibilities of the bacterial cryptic contents after one massive dose of *x*-ray. This case and a few others examined three months after *x*-ray treatment, showed negative cultures for pathogenic bacteria. The results in all cases were not as clean-cut as in this case. This might be explained by the fact that in passing the platinum loop into the crypt no method has as yet been devised whereby the surface of the tonsil can be rendered sterile in order

TABLE I

March 3, 1920

Right Tonsil,	24	hrs.,	50	Colonies	of	Hemo.	Strep.
" "	48	"	100	"	"	"	"
			50	"	"	"	Staph.
Left Tonsil	24	"	50	"	"	"	Strep.
" "	48	"	50	"	"	"	"
			50	"	"	"	Staph.
Vault	24	"	50	"	"	"	Strep.
"	48	"	50	"	"	"	"
			150	"	"	"	Staph.

March 17, 1920—2nd Week After X-Rays

Right Tonsil,	24	hrs.,	No	Colonies	of	Hemo.	Strep.
" "	24	"	"	"	"	"	Strep.
			No	"	"	"	Staph.
Left Tonsil	24	"	"	"	"	"	Strep.
" "	48	"	"	"	"	"	Strep.
			No	"	"	"	Staph.
Vault,	24	"	No	"	"	"	Strep.
"	48	"	"	"	"	"	Strep.
			No	"	"	"	Staph.

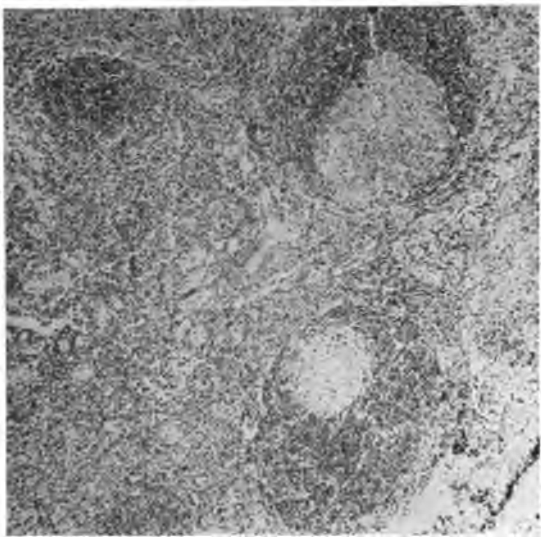

FIG. 2.

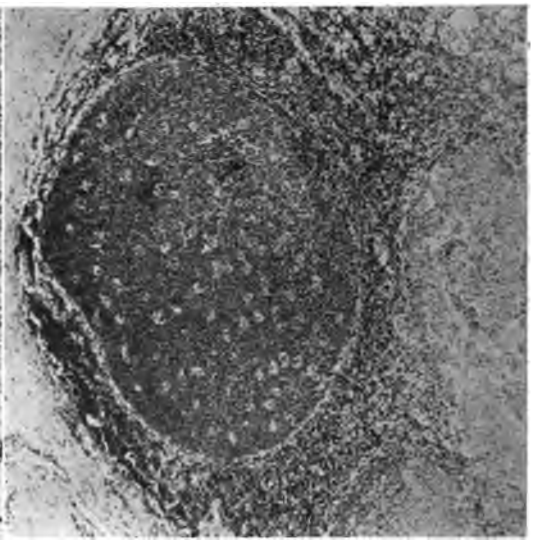

FIG. 3.

to avoid contamination from the mucous membrane. However, this can readily be accomplished with enucleated tonsils by dipping them for one minute in boiling water. Thirty-two out of thirty-six cases showed negative cultures for pathogenic bacteria four weeks after one massive dose of *x*-ray.

Figure 5 illustrates the diminution in size and characteristic changes in the surface of the tonsil at various periods of time after one massive dose of *x*-ray.

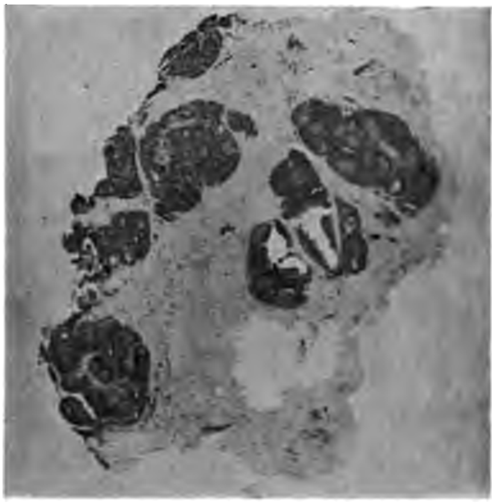

FIG. 4.

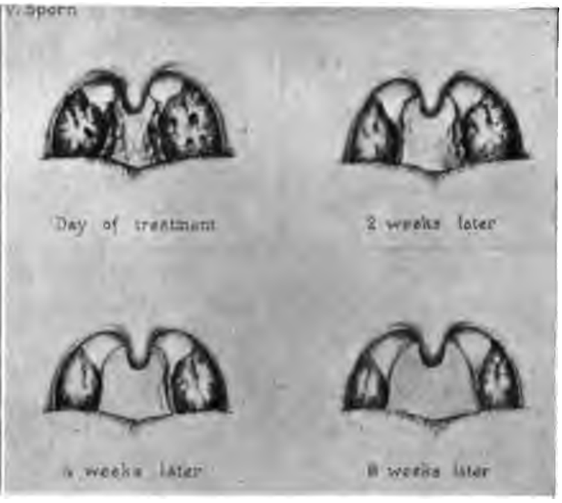

FIG. 5.

x-RAY TECHNIQUE

Figures 6 and 7, illustrating the position and immobilization of the younger patients give a much better idea of the practical application of the *x*-ray than the most accurate description. Figure 6 represents a board 4 feet long, 10 inches wide and 1 inch thick over all. The longest piece for the support of the body is 3 feet. The head piece is 1 foot by 10 inches and 1 inch thick with a bevelled opening 2½ inches in diameter. This opening prevents undue pressure and discomfort of the ear. The distance from the table level to the apex of the angle made by the union of the head piece and body support is 3½ inches. This angle and inclining head board not only give the position necessary for the direct exposure of the adenoids and left tonsil as shown in Figure 7 but also include the right tonsil and adenoids as the rays pass on through the opposite side of the head and neck.

This position can be assumed by the adult patient with the proper placing of pillows or cushions without the use of restraining straps and board so essential in the treatment of young children.

By maintaining the above position and placing the *x*-ray tube at the proper angle in both children and adults it is evident that each tonsil and the adenoids receive two doses of *x*-ray.

The opening in the lead foil, as in Figure 7, should be not less than 3 inches by 2½ inches for the average case. Figure 8 represents the area of exposure, and illustrates the area and position of the patient when a third exposure is considered necessary for cases with extensive growth of adenoids.

DOSAGE

In the experimental series of sixty cases treated at the Institute the following factors were used with 3 mm. of aluminum: 8 in. Sp. Gap. 5 M A 10 in. D and from 3 to 7 minutes time for each exposure depending on the age of the patient.

From the experience with these cases and subsequent treatment of other cases, fractional dosage seems to promise better and more uniform results than the single massive dose used in the above series.

FIG. 6.

FIG. 7.

It therefore seems advisable to give each case at least four treatments as a minimum using the following factors every two weeks: 7 in. Sp. Gap. 5 M A 10 in. D and 3 min. 18 sec. time through 3 mm. of aluminum. These factors give 1 skin unit of filtered ray, which corresponds to ½ skin unit unfiltered in effect on the skin. The same result may be obtained by producing 1 skin unit of filtered ray with a 6, 8 or 9 inch spark gap[5] 5 M A 10 in. D with 3 mm. of aluminum, or if necessary 1 mm. of aluminum could be used instread of 3 mm. to save time, especially with the small (2 K W) interrupterless machines where a 6 inch gap is maximum. The factors for 1 skin unit with 1 mm. of aluminum would be 6 in. Sp. Gap 5 M A 10 in. D and 2 min. 41 sec. time.[3]

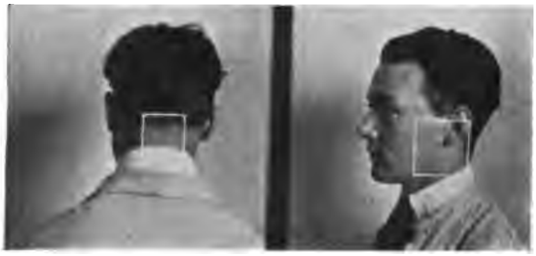

FIG. 8.

The next best method would be two or three massive doses given with four to six weeks intervals.

DANGERS OF FAULTY TECHNIQUE

Before leaving the subject of dosage it is necessary to point out clearly that anyone contemplating carrying out this technique who does not thoroughly understand the part played by each of the four factors of dosage and who has not mastered his machine and tube so that all four factors are constantly maintained throughout the exposure will sooner or later produce an *x*-ray burn with its consequent permanent deformity and tendency to epitheliomatous degeneration. The only contra-indications to the immediate use of *x*-ray are: recent radiographs of the region to be exposed; recent *x*-ray treatment; the external application of any liniment, ointment or lotion other than vaseline, lanolin or cold cream. It does not seem advisable to give *x*-ray treatment during the active stage of an acute infection or immediately after applying nitrate of silver, iodine or any local irritant to the tonsil.

With the present day methods of measuring *x*-ray dosage and the constancy of the Coolidge tube and interrupterless machine, the dangers of the gas tube and the *x*-ray coil are practically eliminated. A Doctor's degree, years of experience in nose and throat, or even in radiography (*x*-ray plates), do not au-

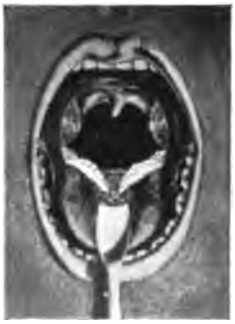

FIG. 9.

tomatically fit any one for the practice of *x*-ray therapy.

On the other hand if the treatment is properly given as indicated, and the time lessened in both the massive and fractional methods of dosage in accordance with the age of the patient, there is not the slightest danger of injuring the skin or any of the adjacent structures, as exemplified in the results obtained for the past twenty years in the treatment of ringworm of the scalp. The immediate and after-effects of excision of the tonsil seem severe as compared with the *x*-ray treatment, which may produce dryness of the throat and a feeling of stiffness in the muscles of the neck. These symptoms are only apparent to the sensitive individual when the massive dose is used.

The extent of any after-effects of discomfort might be explained by citing the case of a young man to whom I gave three massive doses between 4 and 5 P. M., and that night he won the one-mile amateur championship in a local armory.

Recently Dr. Thomas R. French[4] has emphasized the presence of chronic infectious material in the crypts of the infratonsillar nodule as a possible source of systemic infections, and advocates their removal even though the operation is more extensive than that of tonsillectomy.

The infratonsillar nodules or tonsillar branches (Fig. 9) may overlap the under surface of the posterior lateral halves of the inferior lobes of the tonsil.

Those structures frequently referred to as infiltrates or recurrent tonsils are really nothing more than extended and expanded ends of these lymphoid bodies. The fossa, or space between the pillars left after removal of the tonsil, may be subsequently filled by the infratonsillar lymph nodule with its infected crypts. The infratonsillar nodes may progress in size as the tonsils themselves diminish or atrophy. Those nodes in some cases may be larger than their associated atrophied tonsil.

If the infratonsillar nodule with its pharyngeal and lingual branches (Fig. 9) exhibits all the characteristics both pathologically and histologically of the tonsil as indicated in the above article[4] with the results so far obtained with *x*-ray on tonsillar tissues, does it not seem reasonable to infer that not only will cases treated with *x*-ray have their tonsils reduced and crypts evacuated, but that the same process will prevail in the infratonsillar nodule, thus more thoroughly removing the focal infection than by tonsillectomy and that by this means better results will be obtained in combating those systemic infections dependent on this condition, namely, rheumatism endocarditis, chorea, septicemia, etc.?

The results of the study thus far open up possibilities of the *x*-ray in connection with tonsillar disease. One hopeful assistance is in the diagnostic value in determining the relationship between the focus and a given systemic infection, more especially those infections in which pain is a prominent symptom. If the bacteria are the causative factors of such pain, it would stand to reason that their evacuation would be followed by partial or complete relief. In such an event the most rational treatment could be definitely decided upon. Another hopeful assistance from the *x*-ray is to be considered in the possible evacuation of bacteria from the crypts of the tonsil in carriers, especially those of diphtheria and influenza. For it is hardly to be supposed that these bacteria would recur after such evacuation except by reinfection.

CONCLUSIONS

It would seem probable that *x*-ray treatment will be indicated in cases of diseased tonsils and infratonsillar lymph-nodes associated with chronic endocarditis pericarditis, hemophylia, or any co-existing conditions which contra-indicate operation or an anesthetic.

We know that after tonsillectomy in subjects above the sixth or eighth year, and especially in adults, there still remains a considerable and possibly a vast amount of diseased lymphoid tissue containing pathogenic bacteria, in which cases it would seem reasonable to believe that the x-ray will prove to be of value.

It must be understood that this paper is only suggestive, and that the permanency of the results time alone will determine. But the facts in so far as the experimental work has been carried out are presented.

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AN INEXPENSIVE RADIUM CAPSULE HOLDER

By GEORGE E. PFAHLER, M.D.

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THERE is much risk in handling the capsules containing radium element, and in the process of screwing these capsules together or separating them there is unnecessary exposure of the fingers to danger. Any device that will help to keep the fingers at a distance will be useful and will lessen damaging effects. Several capsule holders have already been designed, but each one will fit only the capsule for which it has been made. I therefore searched in instrument stores and elsewhere, but finally went to the hardware store where I found a chuck which is 10½ cm. in length and which can be adjusted to take any of the capsules varying from 4 to 6.3 millimeters. The cost of this chuck is 85 cents, plus the labor of drilling the soft jaws. It is necessary to drill out the chuck in its central portion so that when it is wide open it will just grasp the largest sized capsule. This chuck is superior in my experience to the instruments made costing $12 to $15. It can be lengthened as much as desired by setting the handle into a wooden handle (Fig. 1). The remainder of the metal, if desired, may be covered with rubber. Having just spent twenty-five dollars for a pair of instruments that will not even grasp one size of capsule satisfactorily, I naturally "enthuse" over the above little instrument.

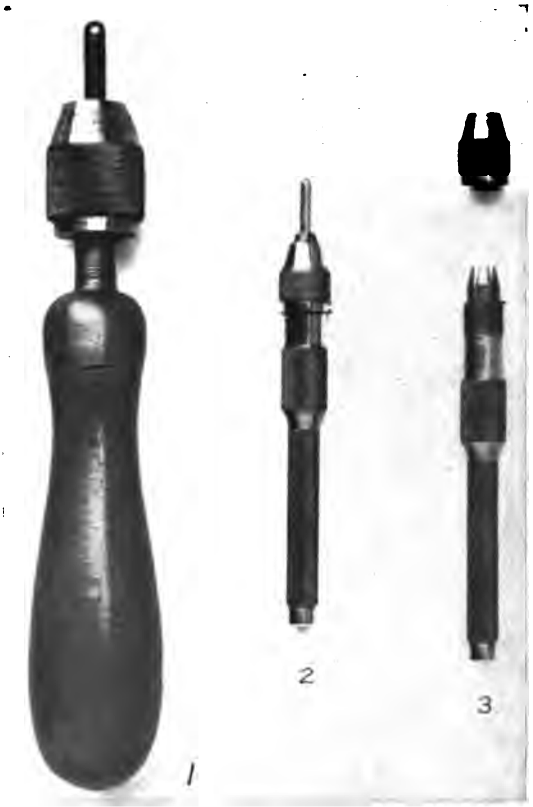

Fig. 1. Goodell Pratt Co. Second Size Drill Chuck. Will take any size capsule. Wood handle can be attached as shown in this figure.

Fig. 2. Starett Pin Vise Grasping one of the Radium Capsules.

Fig. 3. The Same Pin Vice with Cap Removed, showing the jaws which have been drilled out sufficiently to take varying sized capsules.

TWO UNUSUAL CHEST CASES*

By JOHN G. WILLIAMS, M.D.

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CASE 1. *History.*—First seen by Dr. A. A. Rutz, April 11, 1917. Female, age forty-eight. Married, and prior to her marriage a public school teacher.

Past History.—Fifteen years ago she had malaria, and ten years ago typhoid fever. She had never had diphtheria. There have never been any paralyses. Her menstrual history is negative, except that recently the periods have been prolonged.

She has always been of nervous temperament and suffered from gastro-intestinal disturbances. She was irritable and subject to emotional attacks of crying and laughing. These attacks in later life were followed by mental and physical prostration, necessitating rest in bed. At various times she has suffered from pain in the back of the neck and numbness and pain in various regions of the body. There was also insomnia and impairment of memory. She has always been constipated. Excessive secretion of saliva has been noted for years.

Fourteen years ago the patient saved a child from strangulation, a particle of food having entered the child's respiratory passage. This incident impressed itself so firmly on the patient's mind that, from this time on, she suffered from a constant fear of choking during her meals. At times this fear became so strong that it interfered with her deglutition. These disturbances of deglutition were always slight and transitory in character and consisted of sudden regurgitation of food from the esophagus, occasional coughing and choking, and the entrance of food into the nares. Her chief complaint at the time she consulted Dr. Rutz was belching of gas.

Physical examination at this time showed a few râles at the base of both lungs, a palpable right kidney and tenderness over the cecum and ascending colon. The knee-jerks were exaggerated.

On April 20th a test breakfast was given, following which a stomach tube was introduced and the contents of the stomach removed without difficulty.

On April 21st a test dinner was given to determine the gastric motility. A No. 23 French stomach tube was introduced without difficulty, but aspiration was impossible, and inflation showed that the tube was not in the stomach. The tube was removed and again inserted, with the same result, but it was noted that air passed through the tube with respiration. From this it was deduced that the tube was in the trachea and was removed. The patient was asked to swallow, but was unable to do so, as evidenced by failure of the larynx to move. Further examination showed that there was complete anesthesia of the pharynx and larynx. The gag reflex was absent and the insertion of the tube into the trachea caused no reflex cough or discomfort to the patient. The difficulty in deglutition was, at that time, considered temporary and unimportant, and was attributed to the patient's nervous condition, as she had looked forward to the examination with considerable apprehension.

On April 27th Dr. Rutz was called to the patient's home, as her condition had assumed a more serious phase. She was found sitting up in bed, suffering from considerable dyspnea and cyanosis, and imbued with the idea that her dyspnea was due to distention of her stomach. She was belching large quantities of air.

Examination of the abdomen showed no undue distention of the stomach. There was a large number of coarse mucous râles over both lungs. The physical signs in the chest were suggestive of pulmonary edema. Temperature, 101.6. Pulse, 130. Respiration, 36.

The patient was given water to swallow, but no deglutition sounds could be heard at the ensiform. Following this, the dyspnea and other chest signs increased. The cause, nature and seriousness of the patient's condition were recognized. The disturbance of deglutition previously observed had persisted so that her food was entering the trachea, and thereby interfering with respiration and subjecting the patient to the danger of pulmonary infection. Dr. Rutz now sent the patient to St. Mary's Hospital for treatment and observation. Rectal feeding was resorted to at first and later it was found possible, by the use of a stiffer tube, to pass the same into the stomach, and the patient was fed in this way. Excessive secretion of saliva was a constant symptom at this time, but was controlled by belladonna. Her pulmonary symptoms rapidly cleared up and later her respiratory passages showed a marked tolerance to foreign material of various kinds. Various colored solutions were given and later coughed up. At one time six ounces of custard were apparently retained in the respiratory passages for twenty minutes and then gradually brought up by coughing.

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*Thesis presented with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1920.

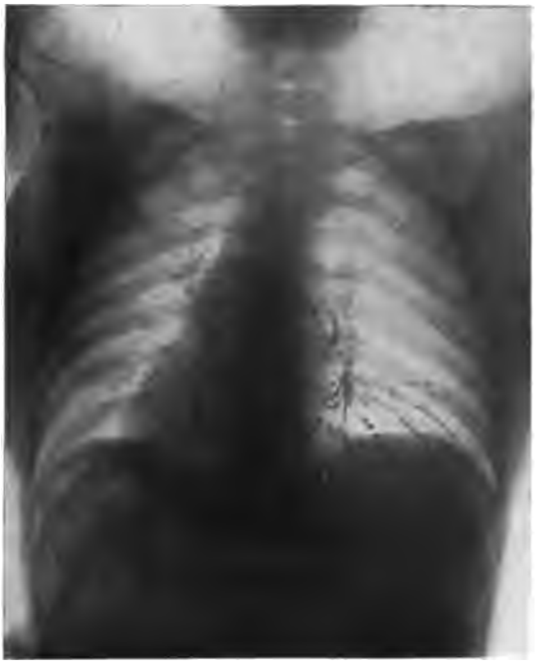

FIG. 1. CASE 1. Bismuth in Both Lungs and also in Larynx.

On May 10th the writer examined the patient at the hospital. Two ounces of bismuth mixture were given the patient to swallow, and on the screen it was seen that most of this entered the trachea and thence on into the bronchi of both lungs. It apparently caused the patient no distress, and she did not cough as a result of it. Stereoscopic plates were then made, and it will be seen from these that the bismith mixture entered the lower lobes of both lungs extending well out into the smaller bronchi. Some few hours later, the patient coughed up much of the bismuth, and two days later the stereoscopic plates showed no trace of it in the respiratory tract.

For three weeks during her stay in the hospital complete aphagia was present. At the end of this time the patient began to swallow normally with occasional remissions, so that at times she had to be fed by tube. She was allowed to return home after four weeks' stay in the hospital, and a member of her family was instructed how to pass the tube and tube-feeding was continued for some time after leaving the hospital. The aphagia suddenly ended when one morning, at breakfast, she had an uncontrollable desire to drink some tea. She drank three cupfuls in succession, and from this time on had no difficulty in swallowing. When last seen, December 1, 1917, she was swallowing in a perfectly normal manner. Sensation had returned to the pharynx and larynx and none of her former symptoms were present.

The diagnosis in this case, made by Dr. Rutz before referring the case to the writer, is hysterical aphagia. The loss of sensation in the pharynx and larynx eliminated the second stage of deglutition, and the larynx was not elevated and protected by the epiglottis, so that, through gravity, the material swallowed dropped directly into the larynx. The retention of foreign material for so long a time in the bronchi indicates that there was diminished sensation here also. Difficulty in deglutition is not uncommon in hysteria and is mentioned in all of the text books on nervous diseases.

On looking up the literature, however, I am unable to find any cases reported in which *x*-ray examination revealed the condition as shown here, except a case reported by Pancoast in THE AMERICAN JOURNAL OF ROENTGENOLOGY, March, 1918, which may be of the same type. He merely says, in regard to the case, that the girl was referred for supposed esophageal stricture, but the obstruction in the esophagus was neurotic in origin.

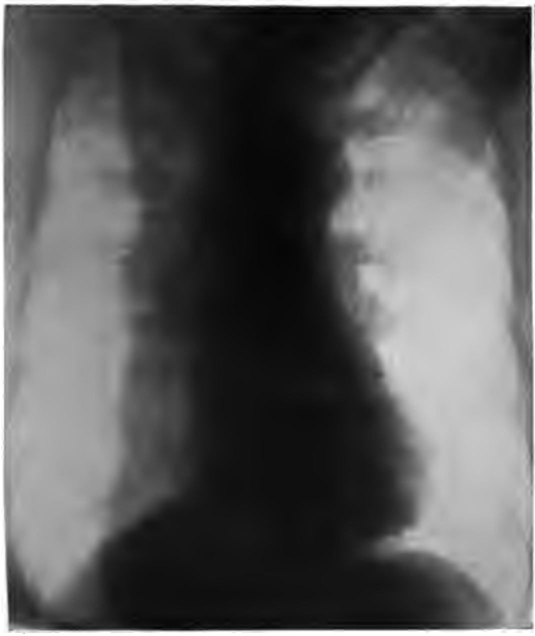

FIG. 2. CASE 2. Plate made before meal showing dilated stomach and esophagus in right mediastinum.

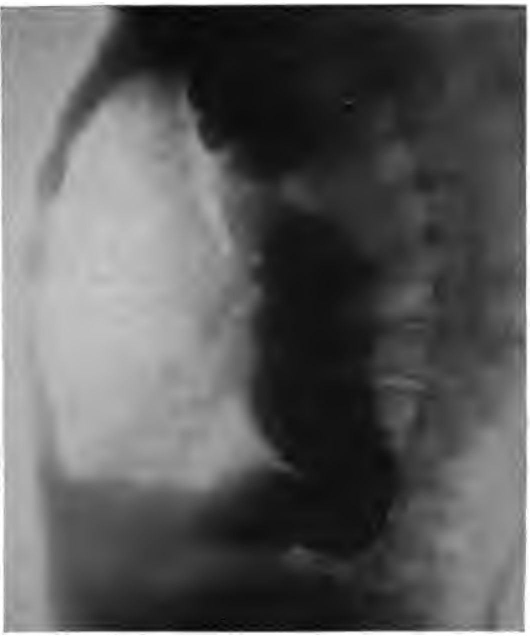

FIG. 3. CASE 3. Right lateral view showing stomach and esophagus with penetrating ulcer on lesser curvature of stomach just above incisura.

CASE II. Referred by Dr. E. P. Porter, for examination of the stomach and duodenum, January 30, 1920.

History.—Male, age fifty-eight; occupation, salesman.

Previous History.—Negative, except for ordinary diseases of childhood. For the past twenty years or more the patient has had more or less digestive disturbances. These consisted of some difficulty in swallowing, in that he had to eat or drink slowly because of some distress in the mediastinum whenever he tried to eat or drink rapidly. He complains of soreness in the right hypochondrium, most marked soon after eating; also some gnawing sensation in the chest, behind the heart. These are relieved by belching of gas after taking alkalies. Occasionally, during the past few years he has had to bring on vomiting by tickling the pharynx to get relief. Of late the symptoms have been more constant and recently, having had a bronchitis, he noticed a tendency to regurgitation when he coughed, especially when lying down. He has never noticed blood in the vomitus, which usually contained food taken several hours previously. His weight was constant up to one year ago, but in the past year he has lost about ten pounds. The bowels are constipated. No history of acute abdominal or chest symptoms and no history of injury to the thorax or abdomen.

On screen examination, there was observed an abnormal shadow in the right chest, extending from the right clavicle to the diaphragm. The margin of this was smooth, except for an indentation opposite the right second interspace. The left margin of this shadow was fused with that of the heart and vessels of the mediastinum. On rotating the patient, it was observed that this abnormal shadow was in the posterior mediastinum. The barium meal was observed to enter the upper portion of this shadow region and was delayed here for two or three seconds and then continued on into the lower part of the shadow, none of it passing below the diaphragm. Meanwhile, a considerable portion of the meal connected in the upper sac.

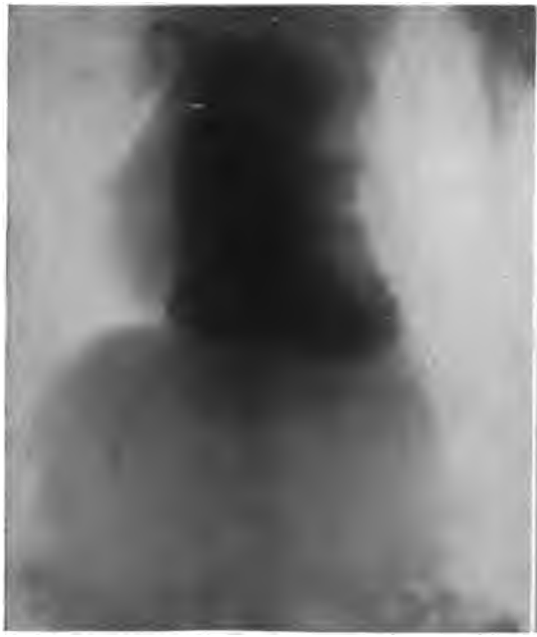

FIG. 4. CASE 2. Six hour plate. Only small amount of barium in intestine.

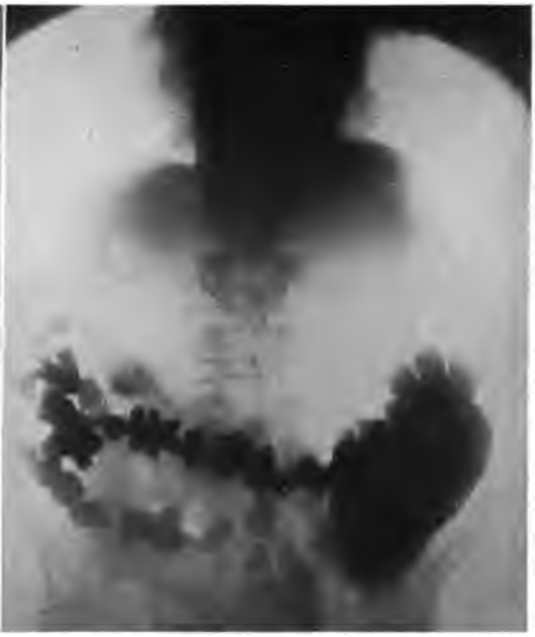

FIG. 5. CASE 2. Twenty-four hour plate. Stomach empty, most of meal being in colon.

Plates were now made in various positions, such as standing direct, oblique and lateral; prone-direct, oblique and lateral. An attempt was made to examine the patient on an inclined plane with the head lower than the feet, but he could not retain the meal in this position. Plates were made six hours after the meal, twenty-four hours afterward and forty-eight hours afterward. Stereoscopic plates of the chest were also made on one of these later visits when the chest contained no barium. Stereoscopic plates were also made in most of the positions above enumerated with a barium meal in the chest.

The plates made without barium in the chest show that this abnormal shadow in the mediastinum is not very dense, as the bronchial tree on the right side may be seen through this shadow. Stereoscopically, it is seen to be tubular and apparently contains air in the lower two-thirds, there being less marked distention above. In the plates made directly with the patient prone, most of the barium is seen in the lower mediastinum, behind the heart shadow. There is some barium also in the upper sac. In this position, the lower shadow assumes the shape of the stomach. In the right lateral position, with the patient lying on his right side, the lower sac seems to be the stomach; and the pylorus and antrum are visible, as well as the greater and lesser curvatures. All of the plates made in this position show a projection from about the middle of the lesser curvature suggesting a penetrating ulcer or adhesion here. The lower sac shows several indentations on both sides, evidently peristaltic waves. The upper sac also shows sharp bilateral indentations suggestive of the haustral markings of the colon. In the plates made with the patient standing, little of the barium remains in the upper sac. The six-hour plate shows most of the meal still in the chest, a small stream being visible in the small intestine below the diaphragm. The twenty-four hour plate shows most of the barium distributed throughout the colon, with a small amount remaining in the terminal ileum. The patient's bowels moved spontaneously at thirty hours, so that later plates showed only traces of the meal in the colon.

From the above findings, I believe that the shadow in the right mediastinum is due to the presence here of the stomach and dilated esophagus above it. There is very little of the small intestine above the diaphragm. The dilatation and hypertrophy of the esophagus are due to constriction of the cardiac end of the stomach. The stomach empties some time between six and twenty-four hours (unable to get intermediate plates). The defective motility of the stomach is due to constriction of the small intestine, at the opening in the diaphragm, and spasm of the pylorus as a result of the lesion on the lesser curvature.

The small intestine is practically empty at the end of twenty-four hours. The condition now present has probably existed for many years. There is no history of trauma and no history of acute abdominal crisis. For this reason, it would seem that the stomach probably passed through one of the normal openings in the diaphragm, most probably the esophageal and that the esophagus was carried up into the chest with the stomach.

Hernia of the stomach and other abdominal viscera through the diaphragm was, until recent years, considered quite rare. However, since the advent of *x*-ray examination of the hollow viscera, the number of cases reported has markedly increased. Particularly is this true since the recent war. Necessarily, there were many wounds of the diaphragm, and as a result of these there have been many cases reported of hernia through these wounds, and some of these cases were not recognized until the patients had been through several hospitals. The cases difficult of diagnosis, even with *x*-ray examination, are those in which the opening in the diaphragm is small and a part only of the stomach or intestine is involved. Soresi has recently reported such cases.

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ANNUAL MEETING EASTERN SECTION

The Second Annual Meeting of the Eastern Section of the American Roentgen Ray Society will be held in Atlantic City at Haddon Hall-Chalfonte, on Friday evening and Saturday, Jan. 28, 29, 1921. Make hotel reservations early, mentioning American Roentgen Ray Society.

Communications regarding the program should be addressed to Dr. David R. Bowen, 82 West LaCrosse Ave., Lansdowne, Pennsylvania.

In all other matters concerning this meeting address Dr. Joseph M. Steiner, 103 Park Ave., New York City.

ANNUAL MEETING CENTRAL SECTION

The Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY will be held on February 21, 1921, at St. Louis, Missouri. Announcement of headquarters will be made later.

Communications regarding the program should be addressed to the president, Dr. James G. Van Zwaluwenburg, Ann Arbor, Michigan. The chairman of the local committee, Dr. Edwin C. Ernst, 412 Humbolt Building, St. Louis, may be addressed concerning matters of arrangements.

THE CALDWELL LECTURE

THE AMERICAN ROENTGEN RAY SOCIETY has sought to honor some of its former members, martyrs to their profession. Two thus far honored are Leonard and Caldwell. At the last annual session, a Leonard prize was voted, details of which will be found elsewhere in this number. Eugene W. Caldwell's work placed him in the foremost rank of American medical scientists, and it is highly fitting that each year the memory of our beloved co-worker shall be freshened by a lecture given in his name. It is planned to have an hour set apart on each annual program for a formal lecture on some topic relating to roentgenology or radiumtherapy, the speaker to be chosen by the president each year. For the first Caldwell lecture at Minneapolis, Minnesota, Thursday afternoon, September 16, 1920, we had the honor and the privilege of hearing Dr. Walter C. Alvarez, Assistant Professor of Research Medicine, George Williams Hooper Foundation for Medical Research, University of California Medical School, San Francisco, California, on "Peristalsis in Health and Disease," whose paper appears in this number. JAMES T. CASE.

COMMUNICATIONS

PARIS LETTER

DURING the course of the war a large number of French and American radiologists had occasion to meet and to work together in the various medical organizations at the front and in the interior. Thus were established those sympathetic and friendly personal relations which make it more desirable than ever that they keep in touch with each other and that they reciprocate in their labors and their researches. Constantly informed by his faithful and eminent friends of the remarkable development of radiology in the United States, and endeavoring to pass on to those about him all that he thus learns, the author of these lines has long hoped that his colleagues in the United States might come to take an equal interest in French radiology.

Fig. 1. Duc de Broglie.

He therefore accepted joyfully, in spite of very numerous duties, the proposition transmitted through Dr. Béclère, Master and Dean of French radiology, to write for the readers of The American Journal of Roentgenology a monthly letter from Paris portraying as faithfully as possible our radiologic activities; and he takes this occasion to congratulate his colleagues, particularly Drs. Hickey and Imboden, on their initiative in creating this new department.

He will endeavor to present in these articles all that is new and interesting in France in the various domains of radiology and radium therapy, and at the same time he will seek to inform those in the United States who may have occasion to come to France as to the hospital services and the laboratories which they will find it most profitable to visit.

Fig. 2. Dr. A. Dauvillier at Work in the Laboratory.

Modern research tends to show that all progress which may be made in the application of the x-rays to medical diagnosis and treatment is inseparable from physical research, and that all productive work thus necessitates the active and continued collaboration of the physicist, the constructor and the radiologist—that is, the constant union of theory and practice.

One of the first to perceive clearly this necessity was the eminent physicist M. Villard, of the Academy of Science, to whom we owe the discovery of the gamma rays of radium, the invention of the osmo-regulator, and the appearance in 1908 of the first apparatus for the measurement of the *x*-rays by ionization. We owe to Dr. Coolidge, together with the most important advance in radiologic technique since Roentgen's discovery, certain facilities for experimentation which profit medicine and physics equally, and which give a new impetus to the collaboration of these two sciences.

A number of French radiologists, therefore, have thought the moment well chosen for the establishment of a laboratory for research in the field of *x*-rays, and to facilitate the study of all questions which may directly or indirectly interest either physicians or technicians.

The Duc de Broglie, well known for his spectroscopic studies of the *x*-rays, and who has at present for his personal use a well-equipped laboratory, has generously offered, to shelter the new organization, an entire building completely furnished and equipped with the most excellent and modern apparatus. Except for the very modest assistance of the writer, the Duc de Broglie oversees entirely the functioning and maintenance of the laboratory, and assumes the scientific direction of it.

Dr. M. A. Dauvillier, a young physician of great future, already known by his interesting work with the *x*-rays, is attached to the laboratory. Some of the readers of this letter will perhaps remember having seen him during the war in the *x*-ray department of the Descartes hospital at Tours, where we first realized the value of an intimate relation between a physical laboratory and a medico-surgical *x*-ray service. For, modest as it was, that laboratory where so often Colonel Shearer lavished upon us the precious counsel born of his long experience, was the scene of some research work which the Academy of Science viewed with interest, and the continuation of which it encouraged with an important prize.

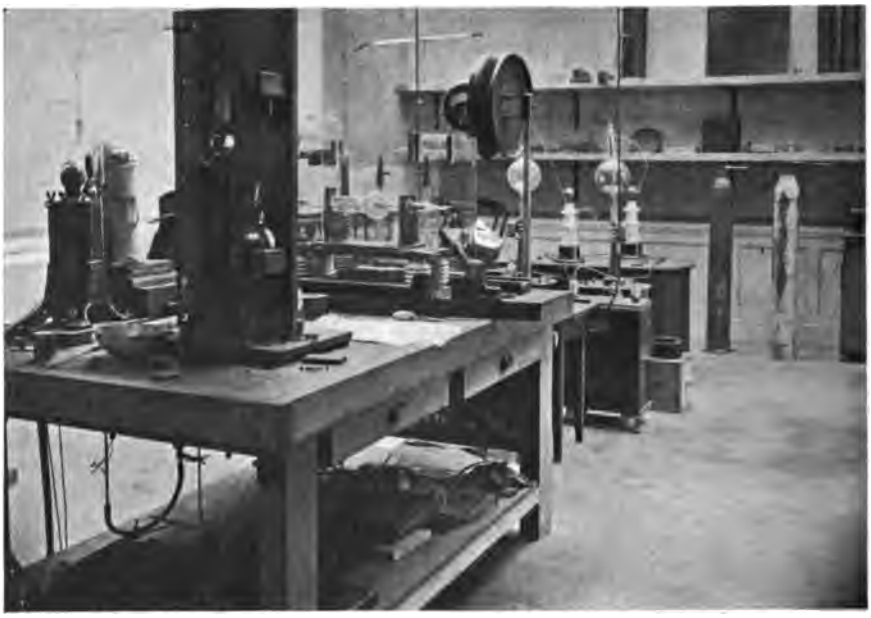

FIG. 3. VIEW OF RESEARCH ROOM IN THE LABORATORY, SHOWING IN THE BACKGROUND HIGH-TENSION TRANSFORMER WITH KENOTRONS AND CONDENSATORS FOR CONTINUOUS HIGH-TENSION WORK. A quartz tube and the Abraham-Villard voltmeter are visible in the center, whilst the vacuum pump shows in the foreground.

We may hope, therefore, that under the direction of the Duc de Broglie, and profiting by his large experience, the laboratory will not delay in giving proof of its utility.

To describe it briefly, it is housed in a building having a basement and two stories.

In the basement are a preliminary vacuum apparatus (a motor and a pump working in oil), and a converter for changing 110 V. D.C. into 250 V. single phase alternating current of 600 periods (60 cycles). This group has a capacity of 5 K.V. A.C. The ground floor includes an office, a dark room, and two laboratories. The smaller laboratory is at present reserved for the study of Lilienfeld apparatus. The larger one contains (a) a coil with mercury interrupter working on the 110 V. D.C., and (b) a Gallot-Gaiffe transformer working on the 120 V. single phase alternating current, and which can supply the incandescent cathode type tubes with a maximum of 170 K.V. controlled by an auto-transformer. Voltages are measured by an Abraham-Villard electro-static voltmeter. This laboratory has also facilities for pumping vacuum tubes, namely, a special quartz condensation pump, with a Gaede rotary pump for preliminary pumping, permitting the obtaining of very high vacuums with considerable speed; and a Pilon apparatus.

The spectroscopic apparatus in use includes a Bragg spectrometer and a Broglie spectrograph. These permit the simultaneous analysis of rays from two sources enclosed in lead boxes of about one cubic centimeter capacity, and having a wall thickness of 15 mm. Two other pieces of spectroscopic apparatus, including a monochromateur, and a spectrograph of special precision for the study of very short wave lengths, are under construction.

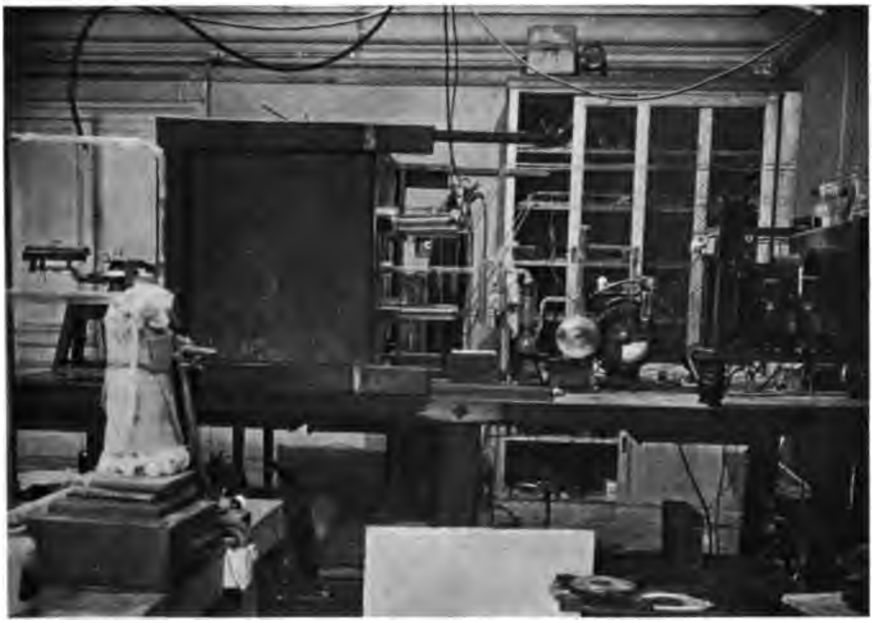
FIG. 4. ANOTHER PART OF RESEARCH ROOM, showing the quartz vacuum pump and Gaede pump on the right, the large lead box (weighing over a ton) in the center, and the spectrometers on the left.

The experimental tubes used are almost exclusively constructed of quartz.

The researches undertaken by the laboratory are not confined to purely theoretical physics. An important place is reserved for all questions of interest from the medical viewpoint, and particularly for radiotherapy, which is closely connected with the study of rays of very short wave length.

Finally, the laboratory, endowed with a very complete library, may be regarded (although not public) as a center where workers lacking information on certain points of physics of radiology may bring their problems, and continue their researches.

If the readers of this first letter reproach us with having dealt exclusively with physics, we hope that Dr. Coolidge, who manifested his interest in the new creation when he visited it last August while it was under construction, and who considered it to be the only institution of its kind in the world, will deign to say a few words in our defense. He will agree with us perhaps that the future of radiology, and particularly of deep radiotherapy—a domain as vast as it is interesting—depends entirely upon the close collaboration of the physician and the physicist.

The description we have given will serve as an introduction to the letters which will follow, and if it has seemed wearisome to some of our American colleagues because we have not spoken of medical radiology, we hope they will pardon us, and we promise them that we will not stray into the domain of physics again for a long time.

DR. R. LEDOUX-LEBARD.

BOOK REVIEWS

THE STORY OF THE AMERICAN RED CROSS IN ITALY. By Charles M. Bakewell. Pages 225. Illust. Price, $2.00. Macmillan Co., 1920.

This most attractive volume is a faithful history of the accomplishment of the American Red Cross in Italy beginning with May, 1915, the date of Italy's entrance into the war, and continuing the narrative until up to the middle of 1919, when Red Cross war activities were practically closed in Italy. The book tells not only of the establishment of relief centers, work-houses, traveling canteens, "asili" for children and large hospitals, but also of the building of entire cities for the accommodation of refugees from the Piave and from Venice. It is highly fitting that the accomplishments of the American Red Cross should be thus chronicled. We hope there will be a wide distribution of this work.

JAMES T. CASE.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Lovett, Robert W., and Wolbach, S. B. Roentgenographic Appearance, Diagnosis, and Pathology of Some Obscure Cases of Bone Lesions. (*Surg., Gynec. and Obst.*, Vol. xxxi, No. 2, August, 1920.)

For the past five years the writers have been concerned in a conjoined study of certain obscure bone lesions, occurring in the orthopedic service of the Children's Hospital. In cases where the diagnosis of a bone lesion was in doubt, the pathologist has been present when operations were to be performed, and has taken his own specimen when the bone was opened, so that if possible an immediate diagnosis could be made by frozen section, and the operative wound treated accordingly. When the pathologist could not make a diagnosis in this way, the specimen was taken to the laboratory, studied, and reported on later. The cases presented are those in which there was, in the minds of the writers, doubt as to the correct diagnosis from the *x*-ray and other data available before operation. Each case is presented with a short clinical history, an *x*-ray and a pathological report. The writers are indebted to Percy Brown, radiologist of the Children's Hospital, for co-operation in the study, and to John J. Morton, of Boston, also a hospital associate, for much labor in the collection and arrangement of the data. Considering the behavior of bone in general, as studied by the *x*-ray, it seems to be a structure of very limited reaction to pathological conditions. Regarded from this point of view, there seem to be only three reactions possible in bone. These are: (1) atrophy or diminution in line content; (2) destruction of bone tissue, local or general; (3) a formative process, characterized by formation of new bone, or a condensation of existing bone around a focus of disease. The general point of view with regard to these processes has been that tuberculosis is largely destructive in character; that the tuberculosis is characterized by marked atrophy of the affected bone, with perhaps atrophy of contiguous bones in the same limb; and that it occurs in the region of the epiphysis. Osteomyelitis has been generally regarded as a process at first destructive in character, and then formative, the formative process generally becoming dominant. Syphilis has been considered as the most purely formative of the three processes, with some element of destruction, but much more formative than either of the others mentioned. When the writers attempted to study, from the point of view of pathological findings, *x*-rays taken of cases prior to operation, it became evident that this criterion could not be depended upon; that tuberculosis, which has ordinarily been spoken of as occurring in the articular ends of bones, might occur in the shaft, and that it might be almost a purely formative process, or that the formative process might exist with the destructive process, and ultimately become dominant; and that a local destructive process, indistinguishable from the so-called Brodie's abscess, might occur in a pure tuberculosis, so that a localized cavity in bone, well walled off, might occur in this disease. It appeared also that a wedge-shaped destruction in the articular end of the bone, with the base of the wedge toward the joint, might occur both in tuberculosis and osteomyelitis, and that under these circumstances the two were practically indistinguishable. The errors in diagnosis, in the experience of the writers, have more often consisted in mistaking tuberculosis for other things than in mistaking other things for tuberculosis. A curious punched out lesion of the skull was identified pathologically in two cases as being definitely tuberculosis. The other confusion which was most troublesome arose between osteomyelitis and spyhilis, two cases involving the lower end of the fibula being shown which were in *x*-ray appearances practically identical. Again, the stage of repair in osteomyelitis may be seen in the *x*-ray of two tibiae to be very similar in spyhilis and osteomyelitis. As it has appeared to the writers, the problem of differentiating the three conditions mentioned by means of the *x*-ray, is not encountered, as a rule, in the routine case in which a purely destructive lesion is most often tuberculosis. The lesion of rapid destruction, with marked formative activity, is generally osteomyelitis, and the purely formative process is most likely to be syphilis. The serious problem of differential diagnosis occurs most often in cases in which focal lesions are present, in which the phenomena of formative and destructive activity have become so mixed that without the pathological examination, in many of them the diagnosis is impossible. The advantage of such a diagnosis made during the operation is evident to any surgeon, because it guides him in the treatment of the bone cavity, and is often the direct factor in deciding whether or not to close such a cavity. In addition to the three conditions of tuberculosis, osteomyelitis, and syphilis, certain other bone lesions are shown, which have a bearing on the question of diagnosis. A short summary of the case histories will be presented, the salient pathological facts discussed, and conclusions drawn as warranted.

DISCUSSION

The diagnosis of infectious lesions of the bones would be simple if each infectious agent always produced the same reaction. The pyogenic bacteria alone may be counted upon to conform to type; at first destruction of tissue followed by repair, which in the case of bone means necrosis with more or less local disappearance of lime salts, followed by new bone formation from adjacent healthy bone structures. It must be remembered in the reaction of bone to injury that new formation of tissue is always followed by ossification and therefore that granulation tissue from bone or periosteum becomes bone tissue. The above simple sequence in the pyogenic infections accounts for the definite criteria applicable in osteomyelitis. It is conceivable that a rapid healing of a small abscess in bone might result in very little granulation tissue production from adjacent tissue with very little production of new bone. Syphilis affects the bone in two ways, both effects of the proliferative reaction of the casual agent, and results either in the destruction of bone, or the new formation of bone. Both effects may occur in the same case. Destruction of bone follows the formation of local, rapidly-formed gummatous lesions, sometimes of endosteal and periosteal origin, sometimes perivascular and extending into bone. On the other hand, the degree of reaction to the spirocheta may be slight and result only in proliferation of cells of the periosteum and endosteum, the newly-formed tissue developing osteoblasts and eventually new deposit of bone is the result. In one case, therefore, there is choking of normal bone by the gummatous process with its necrosis; in the other case there is merely stimulation of bone-forming tissue. Tuberculosis presents more possibilities. In soft tissues it is known that the tubercle bacillus can duplicate the reaction of almost any type of pathogenic bacterium. Thus the various types of exudative response to injury may be the result of the tubercle bacillus alone; exudates essentially fibrinous or essentially puriform in character are frequently found upon serous membranes—meninges, peritoneum, pleura, and pericardium. In bone we usually think of tuberculosis as a proliferative process resulting in the new formation of tissue with consequent obstruction of the bone, and this is the commonest type of tuberculous bone lesion which gives rise to the formation of bone cavities without a peripheral reaction or condensation of bone.

In tuberculosis of bone, as in soft tissues, there may occur: (1) Exudate, fibrinous or puriform, (2) discrete proliferative lesions, the tubercle which may progress slowly or rapidly with much or little caseation, and (3) a diffuse proliferative reaction, following the exudative—essentially tuberculous granulation tissue, with much or little caseation. In the third instance, in the granulation tissue, there may be new bone formation just as in the repair of pyogenic processes, at a time when destruction or resorption of bone is going on.

The important lesson from the pathological study of this series of cases is the reminder that tuberculosis in bone may simulate any other infectious process in location and character of the lesion. Diagnosis from x-ray studies alone is therefore occasionally impossible and recourse must be had to other clinical evidence, and when possible to pathological examination.

CARMAN, R. D., Mayo Clinic. The Roentgen Diagnosis and Localization of Peptic Ulcer. (*Calif. State J. of Med.*, November, 1920, Vol. xviii, No. 11.)

Many roentgenologists refuse to make a diagnosis in the absence of direct signs, and claim that complexes made up of indirect signs are of no value. This view is far too radical, for if roentgen ray diagnoses were limited to cases in which direct signs only are noted, many lesions of the alimentary canal would pass undiscovered. Often more remote phenomena must be considered in the diagnosis, such as alterations of motility, tonus and peristalsis. All of these manifestations are affected by spasm. For instance, we are more or less dependent on changes of contour, spastic in nature but set up by an intrinsic lesion, such as spasmodic hour-glass of gastric ulcer or the spastic deformity of duodenal ulcer. We must also be able to recognize the spastic deformity produced by extrinsic lesions remote from the deformed organ. Such deformity may simulate that produced either directly or indirectly by an intrinsic lesion. Thus two types of spasm are met with; one may be spoken of as intrinsic, the other as extrinsic. The first is often a help in diagnosis, the latter often a hindrance.

He mentions that four types of gastric ulcers may be distinguished at operation.

1. Small mucous erosions and minute, slit-like ulcers.
2. Penetrating, or perforating ulcers with relatively deep craters.
3. Perforated ulcers, with or without the production of accessory pockets.
4. Carcinomatous ulcers.

The first type of ulcer, the small mucous erosion, offers the greatest difficulty to roentgenologic detection. It is either a superficial denudation, or a mere slit in the mucosa incapable of holding enough barium to make a visible projection from the gastric lumen.

The penetrating or perforating ulcer which has burrowed more or less deeply into the gastric wall, but does not penetrate the peritoneal coat of the stomach, produces a definite crater jutting from the lumen of the stomach. The degree of facility with which this crater can be seen by the roentgen ray depends more on the location than on the size of the crater.

The perforated ulcer which has excavated through the peritoneal coat of the stomach may, at the time of perforation, become covered by gastrohepatic omentum, or, if the perforation is chronic, it may be protected by adhesions. In either case the roentgenologic signs are the same as in the penetrating or perforating ulcer before perforation takes place. The only condition indicating perforation, therefore, is the depth of the crater. Perforation of an ulcer with a continuation of the destructive process into adjacent tissue results in the formation of an accessory pocket outside the stomach.

Carcinomatous ulcers are not, as a rule, distinguishable from non-malignant ulcers; their roentgenologic signs are very much the same as those of penetrating and perforated ulcer.

The roentgen ray signs of gastric ulcer may be divided into three groups.

1. Direct signs (pathognomonic).
    a. The niche.
    b. The accessory pocket.
2. Indirect signs (but diagnostic).
    a. Organic hour-glass stomach.
    b. Spastic manifestations.
        1. Spasmodic hour-glass stomach.
        2. Gastrospasm.
3. Corroborative signs (not diagnostic).
    a. Retention from the six-hour meal.
    b. Gastric hypotonus.
    c. Alterations of peristalsis.

Ulcers not sufficiently extensive to produce an excavation that can be visualized on the screen or plate are rarely found at operation; they are mere mucous erosions or small crevices, and their diagnosis can be made only on less definite signs such as spasmodic hour-glass stomach.

Indirect signs (but diagnostic).
1. Organic hour-glass stomach.
2. Spastic manifestations.
    a. Spasmodic hour-glass stomach.
    b. Gastrospasm.

It has been his experience that an hour-glass that resists belladonna to the physiologic effect means a lesion either of the stomach or duodenum; and regardless of whether or not the hour-glass is present at operation, the surgeon will find the cause, if he looks for it.

Corrobation signs (not diagnostic).
1. Retention from the six-hour meal.
2. Gastric hypotonus.
3. Alterations of peristalsis.

Six-hour retention—A distinct residue in the stomach from the six-hour meal is seen in 55 per cent of the gastric ulcer cases. In this respect gastric ulcer stands a close second to gastric cancer. The manner in which an ulcer causes retention is not definitely known in many cases. While it is easy to understand how an ulcer located at the pyloric ring may cause obstruction, it is hard to understand why one situated remote from the pylorus should do so. But practically 90 per cent of all gastric ulcers occur in the vertical portion of the stomach above the incisura angularis. The retentions which they produce have been assigned respectively to pylorospasm excited by the ulcer, to impairment of peristalsis, and to hypotonus. A retention alone is not sufficient evidence for the diagnosis of ulcer, since various causes may operate to produce a six-hour residue.

Gastric hypotonus—An evident loss of tone shown by sagging and expansion of the lower gastric pole is a frequent accompaniment of ulcer, not only of ulcers causing obstruction but also of those situated rather remote from the pylorus. Hypotonus alone possesses little significance, for it is an expected finding in the numerous patients of anteroptotic build; but if the hypotonus does not accord with the habitus of the patient, the possibility of an ulcer should be considered.

Abnormalities of peristalsis.—The variations of peristalsis met with in gastric ulcer include weak peristalsis, hyperperistalsis, especially of irregular type, absence of peristalsis, especially of irregular type, absence of peristalsis from the ulcer-bearing area, and anti-peristalsis. None of these is peculiar to ulcer, but all of them are more or less suggestive of a gastric lesion. All lesions of the gastric wall tend to interfere with peristaltic movement in the area involved. If an ulcer is located at a point where peristalsis commonly is visible a noticeable absence appears in the ulcer area. Anti-peristalsis is occasionally noted with gastric ulcer, and while it is not necessarily indicative of ulcer, it generally denotes the existence of organic disease either in the stomach or duodenum, with or without obstruction.

Carcinomatous ulcer.—The roentgenologic signs of ulcer differ so much from those of carcinoma in the larger number of cases that differentiation requires no effort. A callous ulcer with a niche, or a perforated ulcer with pocket formation, has no roentgenologic resemblance whatever to a well-developed carcinoma. Usually ulcers project from the gastric contour, while in carcinoma the growth with its resultant irregularity extends into the gastric lumen. Between the typical ulcer and the typical carcinoma there is a small percentage of cases in which the roentgenologic differentiation is impossible.

DUODENAL ULCER

He states that the roentgenoligic indications of duodenal ulcer may be classified as follows:

1. Direct signs.
   a. Deformity of the duodenal bulb.
   b. Duodenal diverticulum.
2. Indirect signs (diagnostic).
   a. Gastric hyperperistalsis.
   b. Gastric retention from the six-hour meal (the combination of hyperperistalsis with gastric retention and a normal gastric outline is diagnostic of duodenal ulcer with obstruction.)

He enumerates deformities more or less characteristic of duodenal ulcer as follows:

1. General distortion with the entire contour of the bulb deformed. This distortion is largely due to spasm, which is practically always persistent and unvarying.

2. The niche type in which the excavation of the ulcer is seen projecting from the bulb. This type is rare.

3. The incisura type of deformity, either single or bilateral. The incisura occurs in the plane of the ulcer, and may be the sole abnormality of contour observed. Unusually narrow but of variable depth, persistent and permanent as to situation.

4. The diminutive bulb. This is represented by a small, compact mass of barium in the cap. It is usually produced by an ulcer stenosing the duodenum, so that only the proximal portion of the bulb is filled.

5. The accessory pocket. This results from a perforated ulcer which has invaded tissue outside the duodenum.

6. The diverticulum. A diverticulum in the first part of the duodenum is relatively uncommon. It is found near the pylorus, and its relationship with duodenal ulcer and scars seems well established.

Cases without ulcer are seen in which the bulb fails to show a normal contour simply because of incomplete filling. This is likely to happen in cases in which the duodenum is large, but the deception is evidenced by the varying aspect of the deformity.

In an overwhelming preponderance of cases a constant deformity means duodenal ulcer. Such deformity is not absolutely diagnostic, since distortion of the duodenal shadow may result, though rarely, from an adhesion-producing process in the right upper abdominal quadrant, or possibly from reflex spasm set up by lesions outside the duodenum.

Indirect signs. Hyperperistalsis. Hyperperistalsis consists of three or more waves running along the stomach at one time. It is seen in a large proportion of cases and is most exaggerated in the obstructive cases, but it occurs also when there is no obstruction. A characteristic feature is the regular succession and symmetrical correspondence of the waves on both curvatures. A mere exaggeration of wave depth should not be confounded with hyperperistalsis, since an essential feature of the latter is an increase in the number of waves, although they may also show unusual vigor. Hyperperistalsis is often intermittent in character, periods of activity alternating with periods of rest. Of course the phenomenon of hyperperistalsis is not limited to duodenal ulcer, for it may accompany disease of the gall bladder or appendix or be seen normally in the hypertonic stomach. Obstructing pyloric and prepyloric lesions are sometimes attended by hyperperistalsis, but in such cases the waves are rarely uniform in depth and sequence, and they are chiefly on the greater curvature. Occasionally, however, this variety of peristaltic exaggeration accompanies a perforated duodenal ulcer.

A logical result of hypertonus and hyperistalsis is hypermotility, provided no marked obstruction has been produced by the ulcer. Generally speaking, the initial clearance in cases of duodenal ulcer may vary from a slight increase to a profuse flow or it may be abnormally scant with obstruction, and the moderate intermittent outflow of normal conditions may be absent. Hypermotility is not peculiar to duodenal ulcer, for it is a common effect of gastric cancer, achylia, and the diarrheas. On the other hand, about 25 per cent of the duodenal ulcers are sufficiently obstructive to produce a six-hour retention in the stomach. If in addition to the gastric retention there is a typical gastric hyperperistalsis, the diagnosis of a duodenal ulcer by *x*-ray is quite as certain as a diagnosis on any other evidence that can be obtained.

Clagett, A. V. The Treatment of Goiter with Radium. (*Illinois M. J.*, xxxviii, No. 4, p. 318., October, 1920.)

In the author's opinion, the toxic and Graves' disease forms plus the malignant and parenchymatous types are the only varieties where radium would be beneficial, though experimental work may show it applicable to a few of the other forms.

He has treated to date 47 cases of exophthalmic goiter with radium, the patients' ages ranging from 16 to 74 years. Of these cases six had already been operated on with recurrence of symptoms as bad or worse than before. Seventeen cases were declined as operable risks. Eight cases had to be rayed the second time as the dosage was inadequate and while the patients improved, the first raying did not give satisfactory results. Two cases with very bad broken compensation of the heart have died since treatment from acute dilatation, one three months after treatment, the other five and one-half months, though in both these cases the pulse had showed an average reduction of thirty beats and the nervous symptoms were remarkably reduced. In one case out of five there has been no reduction of the goiter. The circumference of the neck has diminished from 1¾ of an inch to 3¼ inches in the others. One woman's goiter did not decrease until thirteen months had elapsed and then suddenly went down 1⅝ inches in less than two months.

The exophthalmos has been usually the last symptom to disappear and has remained in five of the cases. The pulse beat has been reduced twenty to fifty beats. Nervous symptoms and tremors have disappeared entirely and the patients gained in weight and general well being. There has been symptomatic cure in all of the cases treated with the exceptions noted.

The author believes radium should be given a trial in exophthalmic goiter. Surgery had not been necessary in a single one of the forty-seven cases, some of them extending back nearly three years.

Spencer, Hunter B. Roentgen Therapy. (*Charlotte M. J.*, Vol. lxxxi, No. 6, p. 225, June, 1920.)

The results to be obtained in roentgen therapy are in large measure dependent upon a careful application of the following principles:

1. Correct diagnosis and knowledge of the existing pathologic process.
2. Proper selection of cases and recognition by the roentgenologist of the scope and limitations of this agent.

3. Knowledge and experience necessary for the proper administration.

4. Co-operation of the patient and the family physician referring the case.

Indications for treatment by the roentgen ray are—well advanced anemia, organic heart disease, diabetes mellitus, chronic nephritis, lung disease and goiter with heart symptoms, all patients beyond forty in whom there is no contra-indication. Young women in whom it would be necessary to do a hysterectomy in order to remove the growth.

Contra-Indications.—Where there are small pedunculated tumors, in young women healthy otherwise, which can be excised without destroying the reproductive powers of the patient. When tumors are complicated by malignant degeneration or are beginning to become necrotic. When associated with disease of the adnexa, or when the patient's condition is such that the danger of an operation is less than that of a delay of six or eight weeks which would be necessary to obtain results.

The experience of the writer and that of other roentgenologists would suggest the following conclusions:

Deep roentgen therapy stops the hemorrhage caused by uterine fibroids which is followed by a gradual disappearance of the tumor.

The treatment of metropathic hemorrhage is practically always successful.

Uterine hemorrhage occurring at or near menopause, when not due to malignancy, will usually disappear quickly.

Roentgen therapy is a most valuable aid to the gynecologist.

Rinehart, D. A. Evidence of Gastrointestinal Disease as Revealed by Roentgenological Examination of the Digestive Tract. (*J. Arkansas Med. Soc.*, Vol. xvii, No. 5, p. 107, October, 1920.)

Roentgenological examination as a means of diagnosing diseases of the gastrointestinal tract has a distinct field of usefulness. There is no other procedure that permits as close and careful observation. It must be emphasized, however, that only those conditions which produce permanent change in the stomach or intestine can positively be detected by its use. Gastric and duodenal ulcer, and gastric cancer are the affections of the stomach most readily diagnosed by roentgenological examination. The reliability of the conclusions depends on the carefulness with which the examination is made.

Frequently the evidence will be sufficient for the roentgenologist to make a positive statement; again, the findings may be suggestive but not diagnostic. In the latter instance he can say that pathology exists at such a place or he can give his opinion of the cause of the trouble with the reasons for his belief. In this instance his diagnosis should be accepted as merely an expression of his opinion.

Marty, L. A. The Modern Treatment of Malignancies. (*J. Mo. M. Assn.*, Vol. xvii, No. 7, p. 271, July, 1920.)

In the year 1918 there were over 65,000 deaths in the United States from cancer. Put the life of a cancer patient at three years and you have a total of about 200,000 people suffering at all times from this disgusting and painful condition. Are we doing our best for these cases, or are we in a hopeless state of mind, feeling that there is no cure? The best treatment for this class of cases consists of thorough raying before operation, careful surgery, followed immediately by thorough raying, and this continued over several months.

Treatment by the ray is always in order, even in the completely hopeless cases, as much suffering is relieved, toxemia lessened, and the patient made more bearable to those about him.

Krupp, D. D. The *X*-Ray As an Essential Guide for Producing Artificial Pneumothorax in Advanced Cases of Pulmonary Tuberculosis. (*N. York M. J.*, October 30, 1920, p. 670.)

In advanced cases of pulmonary tuberculosis, the almost constant harassing cough and frequent hemorrhages are the most difficult symptoms to treat.

With the production of an artificial pneumothorax, the affected lung is collapsed and the annoying symptoms are more or less permanently relieved, certainly to a more marked extent than by the use of narcotics, and without their depressing effects. The purpose of the pneumothorax in these cases is not to produce a cure, primarily, but to render the patient's life more comfortable and possibly increase his chances for recovery.

In certain seemingly hopeless cases, the treatment has caused an apparent arrestment of the disease in three selected cases cited in this article. Two of the advanced cases became ambulatory, after the patients had been bedridden for almost a year. They have shown a great amount of improvement.

Before a pneumothorax is tried the *x*-ray stands out as the essential guide to the clinician. The fluoroscope is part of the guide. With the bedside unit, the hand fluoroscope is used to great advantage. The *x*-ray plates give the pathological findings as a permanent record, while the fluoroscope gives a clue as to the mobility of the chest and the excursion of the diaphragm of the affected side.

The following points were studied before pneumothorax was produced: (1) The extent of the pathology, especially as to cavities. (2) Will the opposite lung be able to furnish sufficient pulmonary tissue after the affected lung has been collapsed in front throwing additional risk to the patient? (3) Pleurisy and adhesions.

Curtis, Arthur H. Radium Treatment in Gynecology. (*Wisconsin M. J.*, Vol. xix, No. 4, p. 172, September, 1920.)

The author has used radium for a period of five years. Each year there has been a relative decrease in the percentage of major operations, with a corresponding increase in the proportion of radium cases.

In the cases of uterine carcinoma very few cures have been obtained. This is ascribed to the fact that until very recently only those with bad prognosis have been reserved for exclusive radium treatment, and then, post-operative radium therapy has not been pushed to the limit. In spite of these unfavorable statistics, experience supplies an ever increasing evidence that radium is the best palliative remedy at our disposal in the management of uterine cancer and may entirely supplant radical operation in the treatment of this disease.

Except in very few instances of 62 fibroid cases no attempt has been made to avoid bringing on the menopause. Treatment has consisted in curettage, with intrauterine application of 50 milligrams for a period of 20 to 24 hours.

Radium makes possible a revival of treatment by myomectomy, favorable cases may have the larger tumors removed, and thereafter go through pregnancy with the assurance that radium will obviate the need of a second operation if other fibroids develop subsequently.

In 81 cases of the menopause hemorrhage was invariably controlled. The technique was essentially that used for uterine fibroids.

Fischel, E. The Use of Radium in Carcinoma of the Face, Jaws and Oral Cavity. (*J. Mo. M. Assn.*, Vol. xvii, No. 7, p. 267, July, 1920.)

In the author's experience, radium can be relied on to heal carcinomatous ulcers of the face. It is the most efficient method of treatment of carcinoma o fthe eyelids and has replaced operative treatment of carcinoma of the lower lip in a percentage of cases. Tributory glands should be removed by open operation.

The initial dose of radium should be the maximum one deemed necessary for the complete destruction of the carcinoma.

The persistent use of radiation after demonstrated failure of the growth to respond favorably is to be condemned.

Radium has limited use in carcinoma of the jaws and buccal cavity.

As an adjunct to surgery, radium is of great value, as its small bulk, diffuse and powerful action permit it to be implanted in small cavities otherwise inaccessible to any method of approach.

Schmitz, Henry (Chicago). The Indications for Radium Therapy in Surgical Conditions of the Pelvic Organs. (*Wisconsin M. J.*, Vol. xix, No. 4, p. 157., September, 1920.)

The biological reaction of cancer cells to radiation offers the best evidence of the therapeutic and curative efficacy of the gamma rays of radium and the hard roentgen rays. The efficacy of the treatment must be based on the demonstrable reduction in the size of the tumor and not on the local changes and improvement in the subjective condition of the patient.

Considering that surgery can remove carcinoma tissue but not change the proliferative activity of the cancer cell and that radium and roentgen rays will arrest the active mitotic power of cancer cells but cannot remove them, it is obvious that in the treatment of cancer disease we must resort to the combined method of surgery and ray therapy provided the case in question is a clearly operable one. In borderline and clearly inoperable primary and recurrent carcinomata we must confine the treatment solely to ray therapy.

The author reports the clinical results observed in 265 cases. Subtracting 21 clearly operable cases, there are left 244 that formerly would have been considered absolutely hopeless. Thirty-two of the 244 cases have survived a period of two or more years, during which time they enjoyed perfect health and working capacity. Eleven of these have succumbed and 21 are alive.

GIFFIN, C. E. Artificial Menopause Induced by the *X*-Ray. (*Colorado Med.*, Vol 17, No. 4, p. 84, April, 1920.)

This report is based on thirty consecutive cases selected for *x*-ray treatment between the year 1914 and 1920. Excessive menstrual flow constituted the chief indication for treatment in thirteen cases of this series. Many of them were cases of menorrhagia of the early menopause. Of these thirteen complete arrest of hemorrhage and complete suppression of menses were attained in each instance.

In five cases the reduction of definite fibroids was the chief indication for treatment.

Combined indications of menorrhagia and palpable fibroids were frequently encountered. There were six such cases in this group, making a total of eleven in which fibroids were a factor. Of these eleven, symptomatic cure was attained in each instance but three.

Recurrence of flow following primary discharge from treatment occurred in four instances.

Twenty-one of the thirty manifested before the completion of treatment more or less symptomatology suggestive of the menopause. In two of these cases the symptoms warranted the use of ovarian extract.

As to technique: The first dose is administered in halves with one week interval; beyond that the patient is given the full dose at one sitting and that is repeated every three weeks until one period is definitely missed. In the fibroid cases treatment is continued with a four weeks interval until the desired result is obtained. Only two areas are exposed, one anterior just above the pubes and the other posterior over the sacrum. The treatment cone is six inches in diameter and is provided with a three and one-half mm. aluminum filter with a wooden compression surface on the opposite end. A supplementary filter of one and one-half mm. is always added in treatment of this class of cases. The exposure time is sixteen minutes in the anterior and sixteen in the posterior position, with a spark gap of seven and a half inches with five ma. going through the tube. The skin-focus distance is always nine inches.

Age is the essential factor in determining the number of exposures required for menstrual suppression. Anatomical conformation is the other factor. When these are known it is surprising how accurately one can estimate the probable total time under treatment. Ages ranged from twenty-eight to fifty-four in this series. The fewest number of treatments given was three, in one of the cases close to the time for the natural menopause. The greatest number was thirteen, in one of the younger of the series. The average time under treatment was twenty-one weeks.

In conclusion the author emphasizes that careful history, examination and care in selection can define a large group of pelvic cases which are better treated by the *x*-ray than by any other means available. On the other hand, without the greatest of care, the *x*-ray may easily inflict upon the patient irreparable disaster.

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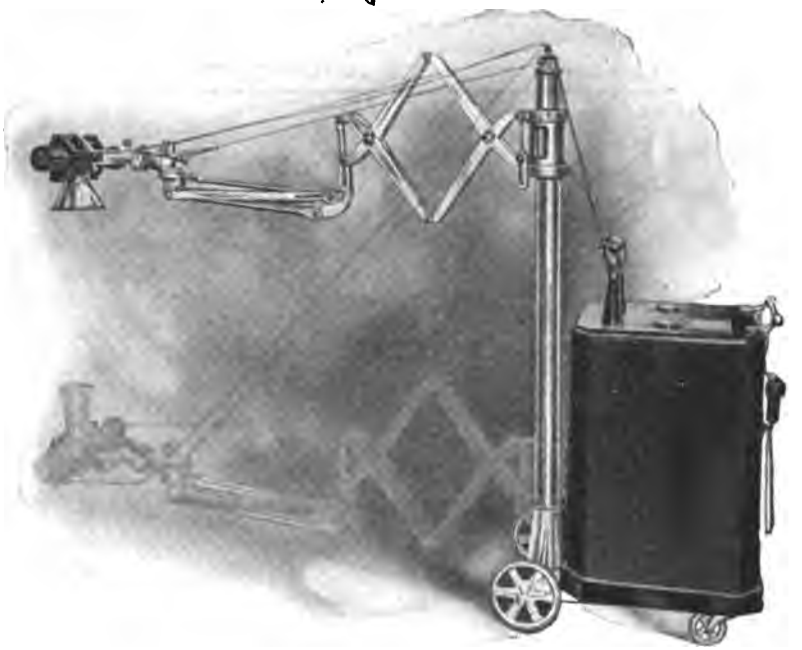

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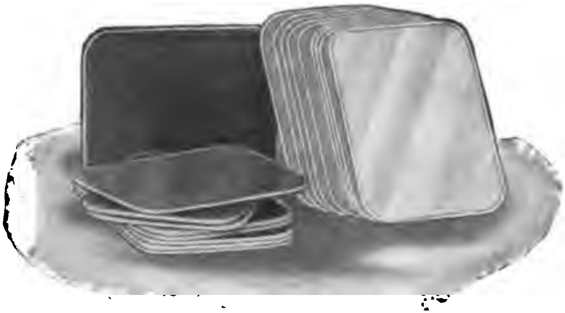

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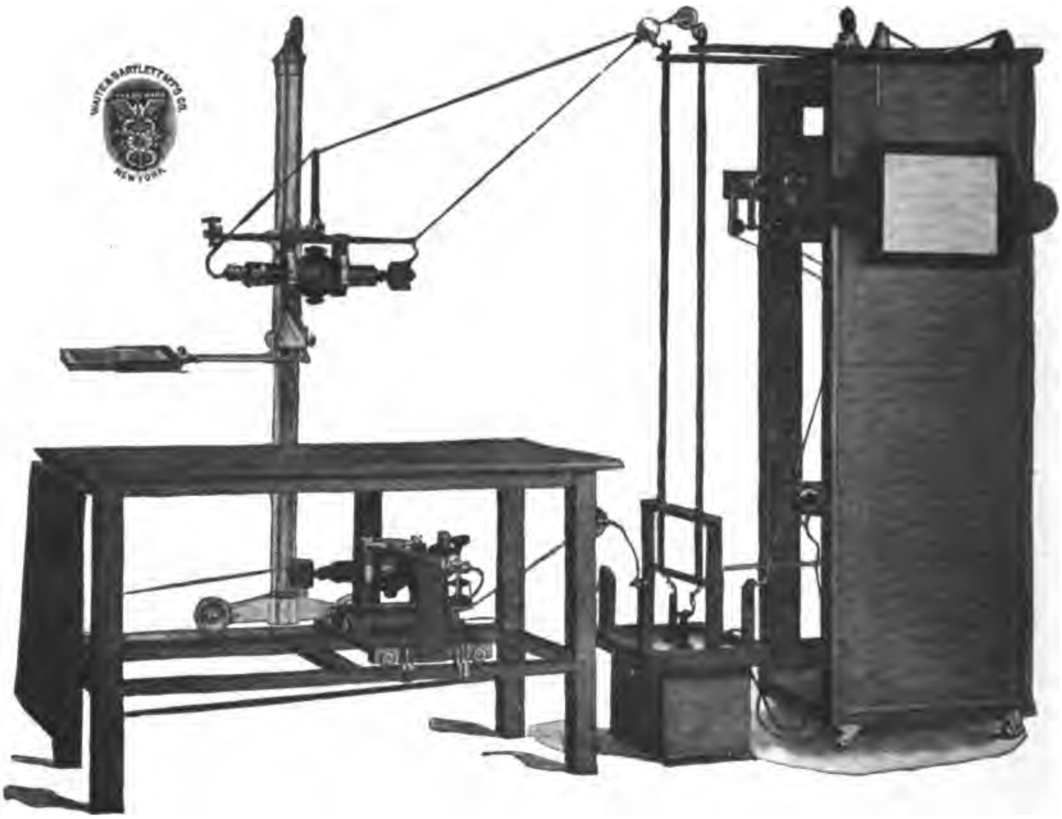

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i, Anatomical Key Plate; ii, Furunculosis in the Auditory Canal; iii, Simple Acute Mastoiditis; iv, Simple Acute Mastoiditis; v, Severe Mastoiditis with Mild Symptoms; vi, Mastoiditis with Bone Absorption; vii, Beginning Abscess Formation; viii, Asymmetrical Mastoids and Thin Cortex; ix, Perisineus Abscess; x, Perisineus Abscess and Sclerosis; xi, Extensive Perisineus Abscess; xii. Large Cholesteatoma; xiii, Cyst of the Mastoid; xiv, Diploetic Type and Chronic Otitis Media with Sclerosis; xv, Undeveloped Mastoids; xvi, Chronic Otitis Media; xvii, Infantile Type, Age 5; xviii, Epidural and Perisineus Abscess; xix, Mastoid Operation with Complete Removal of Cells; xx, Mastoid Operation with Incomplete Removal of Cells; xxi, Large Emissary Vein.

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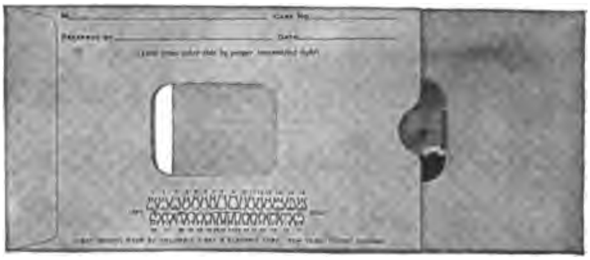

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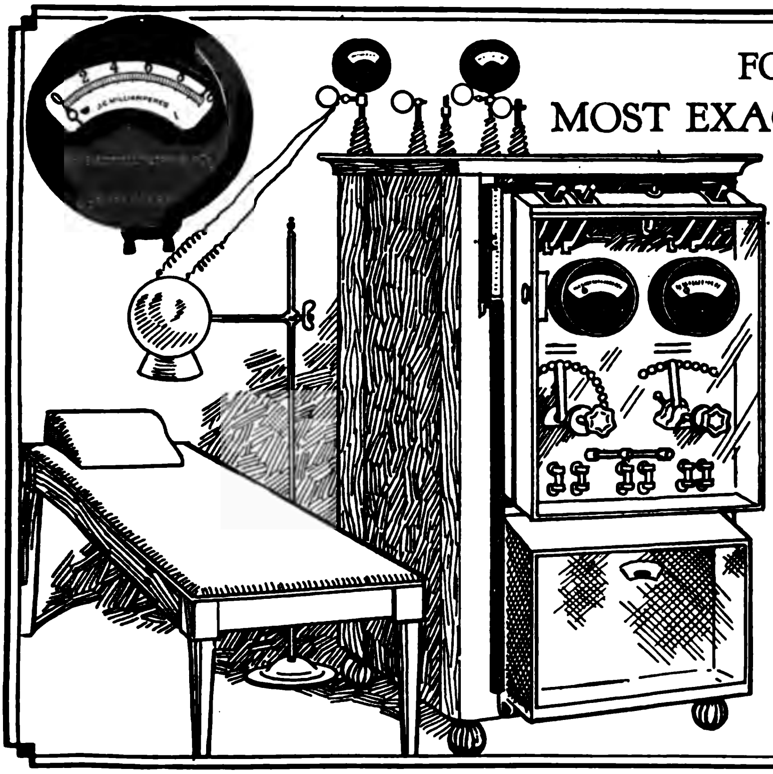

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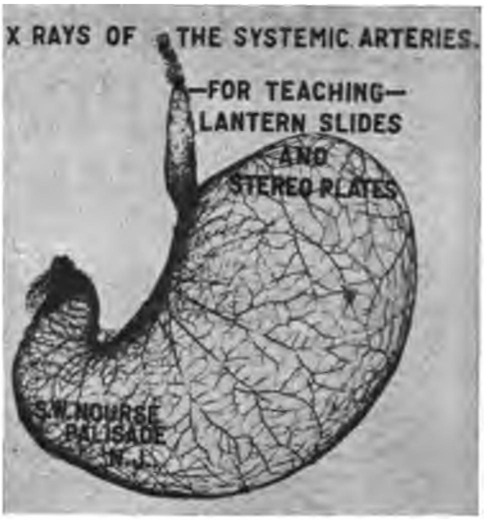

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VOL. VIII (NEW SERIES) FEBRUARY, 1921 NO. 2

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Upon investigation Dr. Stewart found that a number of similar cases had been reported. It occurred to him at that time that with proper precautions the injection of opaque substances into the lung through the bronchoscope could be safely undertaken.

It was evident that advancement along this line was slowly being made, for in 1917 Dr. Sidney Yankauer treated a case of bronchiectasis by direct applications of iodine solution to the diseased area through the bronchoscope. In conjunction with Dr. Willy Meyer and Doctor Yankauer, this patient was carefully watched roentgenographically. Complete recovery occurred.

Between 1915 and 1920 two cases of tracheo-esophageal fistula came under observation in which the main bronchial tree on both sides was outlined by bismuth paste escaping from the esophagus through a fistula into the trachea. Early in 1920, the same phenomena occurred in a case of carcinoma of the esophagus located just above the arch, complicated by laryngeal paralysis; also, in a patient suffering from carcinoma involving the laryngopharynx. In both these cases the bismuth paste entered the trachea beneath the epiglottis, which was imperfectly closed. Repeated roentgen examination of these two patients did not cause any ill effect.

During Dr. Stewart's army experience at Biltmore, N. C., while examining patients suffering from chronic empyema, he frequently injected bismuth mixtures into an empyemic cavity which had direct communication through a pleuro-pulmonary fistula with a branch bronchus. The bismuth mixture would permeate many of the bronchial branches, be retained long enough to enable him to obtain satisfactory roentgenograms, and then would be expectorated. Such an occurrence, whether accidental or intentional, did not seem seriously to disturb the patient.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

The experience mentioned above strengthened his belief that if accidental entrance could occur without danger, injections might be done deliberately and, when combined with roentgen examination, be used for diagnostic purposes.

Dr. C. Jackson, of Philadelphia, during 1918, reported a case before the American Laryngological Association, in which the main bronchi on the right side were outlined roentgenographically, after insufflating dry bismuth through the bronchoscope.

Drs. J. C. Bullowa and C. Gottlieb of New York, in 1919, reported some experimental studies on living animals in which the bronchi had been injected with bismuth and barium mixtures, roentgenographic observations of which brought out details of the bronchial tree heretofore never thought possible. They were able to demonstrate a "wave-like" peristaltic action in the bronchi and trachea.

So far as we are able to ascertain, it was not until early in 1920 that any successful efforts were made to outline roentgenographically lung cavities after the injection of opaque substances through the bronschscope. In May, 1920, Dr. Lynah, of New York, presented a short preliminary report on the subject before the American Laryngological Association; he reported two cases of lung abscess which had been successfully mapped out roentgenographically after the injection, bronchoscopically, of aqueous and oily mixtures of bismuth subcarbonate directly into the area of diseased lung; both these patients have since been repeatedly examined by the authors and are included in the five cases reported in this communication.

Case I. A man of twenty-six years who developed a lung abscess in July, 1919, after having aspirated sea-water while in swimming. He went out too far, became exhausted and went under; was hauled out and by first aid measures soon revived.

One week later he suffered from what was supposed to be bronchopneumonia; there was a great deal of foul expectoration at that time.

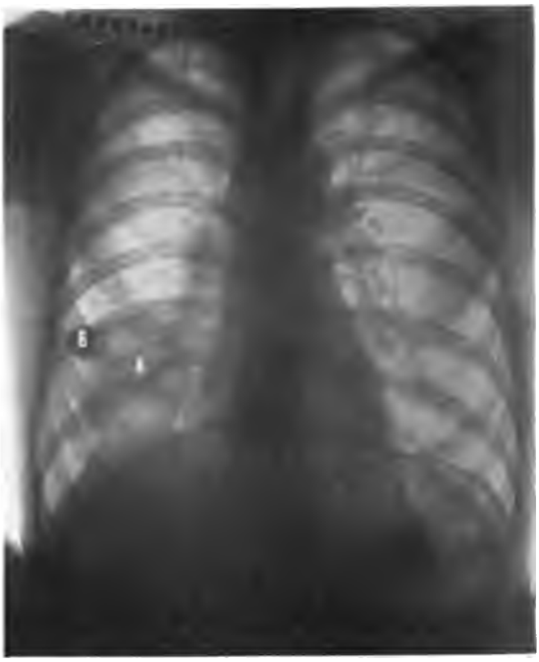

Fig. 1. Case 1. Lung Abscess One Month after First Injection. A. Abscess cavity faintly outlined. B. Remains of bismuth which infiltrated the lung structure at the time of the first injection.

Within one month the acute symptoms had subsided, but he continued to expectorate large quantities of pus. He was sent to New Platz, N. Y., with a diagnosis of pulmonary tuberculosis even though no tubercle bacilli were found in the sputum. There he had several hemorrhages; the sputum showed numerous streptococci, he had fever and complained of having a "bubbling" sensation in his right chest. There were several night sweats. In February, 1920, the patient consulted Dr. F. W. Corwin of Newark, N. J., who referred him to Dr. Lynah for bronchoscopic examination.

Roentgenographic studies made by Dr. Corwin showed a definite shadow over the right lower lobe surrounded by a "pus soaked" area of infiltrated lung tissue. The diaphragm was attached and pulled upward. The roentgenologist in his report stated that there was a fluid level and gas bubble in an abscess cavity; this however Dr. Lynah was unable to make out. There was profuse expectoration of foul smelling pus, and the patient stated that he had coughed up as much as would fill two large preserve jars every twenty-four hours.

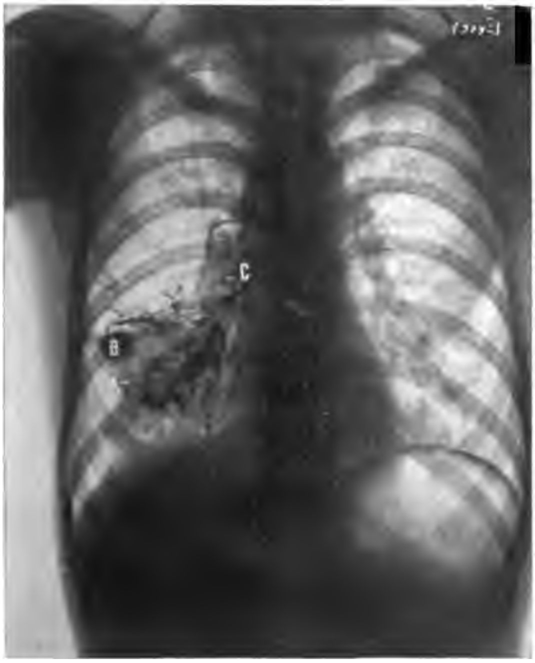

FIG. 2. CASE I. LUNG ABSCESS. IMMEDIATELY AFTER SECOND INJECTION. A. Abscess cavity outlined with bismuth suspended in sweet oil. Small cavities and bronchial branches in involved area also outlined. B. Remains of bismuth infiltrated into lung structure from first injection. C. Main bronchial branches.

He was bronchoscoped after further study of the roentgenograms. The bronchoscopist noted a profuse discharge of pus pouring out of the mouth of the bronchoscope. It was very foul smelling and blood-tinged. A 7 mm. bronchoscope was introduced so as to make it possible to study and explore the lower lobe branches. After thorough evacuation of the pus-filled bronchi, the superior lobe branch on the right side was examined and found, on coughing, to be free from pus. Pus was noted coming out of the right middle lobe branch, which was directly anterior, but, after this branch was sucked out, and the patient instructed to cough, no pus was in evidence. The lower lobe branches were filled with pus; this was removed by suction and each branch examined in turn and the patient instructed to cough; by this means the branch bronchus from which the pus was coming could be definitely located. The small, but constant ejection of pus with each cough, pointed toward the right anterior branch; this branch was sucked out; however, pus appeared in the mouth of the bronchus with each cough in spite of suction. The long slanting end of the bronchoscope was then insinuated into this branch. It was now noted that there were many granulations present which bled freely. About one ounce of bloody pus was aspirated at this time into a sterile bottle and examined by Dr. George S. Dixon of the New York Eye and Ear Infirmary,

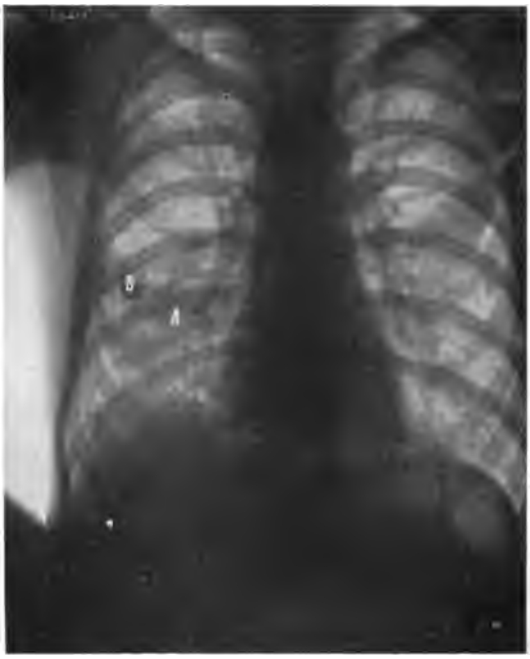

FIG. 3. CASE I. LUNG ABSCESS FIVE MONTHS AFTER INJECTION. A. Area of diseased lung. B. Small amount of bismuth still remaining in lung structure from first injection.

who reported as follows: "The pus removed bronchoscopically from the lung abscess of Mr. F. H. shows a pure culture of Freelander bacillus." This was extremely interesting, for the most virulent cases which we see in the summer caused by swimming about New York harbor are usually due to the Freelander bacillus, one of the colon group. This man had a lung abscess caused by the inspiration of sea-water about New York harbor.

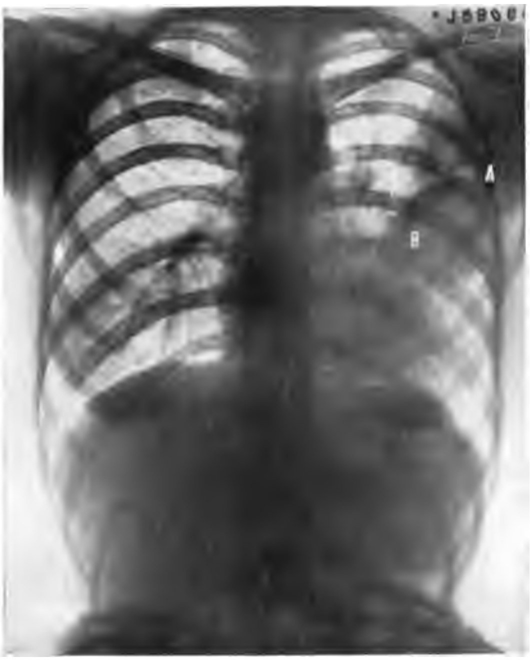

Fig. 4. Case II. Lung Abscess Before Injection. A. Abscess cavity showing fluid level with air bubble above. B. Pus soaked in filtered area of lung structure surrounding the abscess.

For definite lung mapping the abscess cavity was injected the following week with a mixture of bismuth subcarbonate in olive oil (1–2). The right anterior branch was injected around a corner by a specially made curved spiral cannule; 8 c.c. of bismuth mixture was injected slowly so as not to infiltrate the surrounding lung tissue, and within five minutes from this time the patient was flurorscoped by Dr. Charles Gottlieb,, and some very interesting observations made. By fluoroscopy the cavities filled with the opaque mixture could be distinctly seen. Roentgenograms were also taken in all positions and a set of stereoscopic plates made. Within ten minutes the patient was again fluoroscoped and the bismuth mixture was seen coming out of the abscess cavity and flowing upward.

He had not coughed up to this time, for he was breathing as quietly as possible. He did have considerable cough, however, immediately after the removal of the bronchoscope, but the fluoroscopic studies made by Drs. Gottlieb, Corwin and Lynah did not show any bismuth in the bronchi; it was only in the abscess cavities. While the bismuth was coming out of the abscess cavities into the bronchial tree, it was noted that it did not flow downward but upward, and roentgenograms taken at the time showed the middle and superior lobe branches well outlined by the opaque mixture while the lower lobe branches remained free. Shortly after the patient complained of such bubbling that he was compelled to cough, and expectorated about 2 c.c. of the bismuth mixture.

From these observations, Drs. Gottlieb and Lynah agree that probably there is another mechanism besides cough and the action of cilia which causes expulsion of secretions from the tracheo-bronchial tree.

Roentgenograms taken before the injection did not show a definite outline of the abscess.

Another injection of bismuth was made one month later, at which time the roentgenographic studies were made by Dr. Stewart at the Lenox Hill Hospital, who reported as follows:

"Fluoroscopic and roentgenographic examination, to ascertain how long the bismuth would remain in the abscess cavities and also how long it remained in the lobular structure into which it had infiltrated, showed that the bismuth mixture started to make its exit from the bronchial tree within a short time after injection. It remained much longer in the abscess cavities and lobular structures, but eventually disappeared." In abscess cavities it may remain from two weeks to two months, the shadow growing less opaque until it finally disappears. This perhaps accounts for the improvement of the patient and the diminution of the quantity of pus expectorated and the disappearance of odor. The injection of bismuth mixtures, while done for the purpose of outlining the lung in order to locate definitely the abscess cavities, seemed to have a beneficial effect on the patient. There was no odor to the pus expectorated after the second injection; this was so pronouned that the patient noticed it himself and said that he no longer had a foul breath, for the bad smell and taste had disappeared.

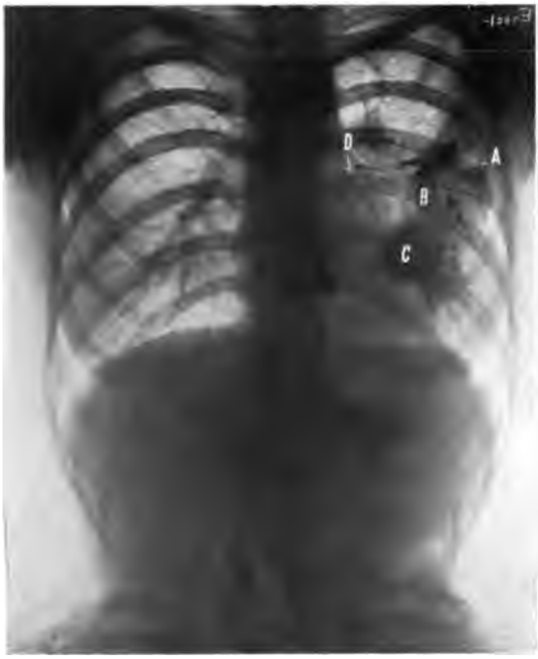

Fig. 5. Case ii. Lung Abscess Directly after Injection. A. Abscess cavity outlined with bismuth suspended in sweet oil. B. Bismuth outlining small cavities surrounding large as well as dilated bronchial branches. C. Bismuth infiltrated into lung structure. D. Main bronchial branches.

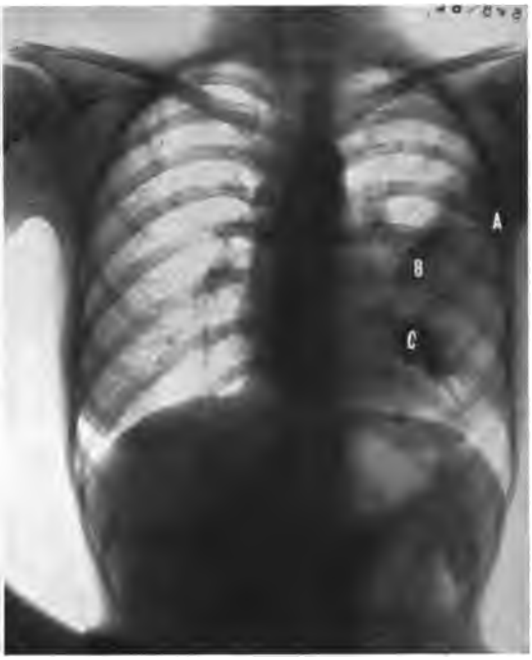

Fig. 6. Case ii. Lung Abscess Two Months After Injection. A. Remains of abscess cavity. B. Small amount of bismuth still remaining in contracted cavities. C. Remains of bismuth which infiltrated lung structure.

This case is still under observation.

Case II. A young lady of twenty years was seen in consultation with Drs. Willy Meyer and Richard Jordan. The patient was admitted to the Lenox Hill Hospital and bronchoscoped shortly thereafter. Roentgenograms showed what appeared to be a very large abscess in the left upper lobe well out toward the periphery, which from the "pus soaked" spongy lung structure surrounding it appeared much larger than it really was, and also suggested some pleural involvement.

The patient had had a tonsillectomy performed one week before admission by an expert laryngologist. At the time of admission she was expectorating 250 c.c. of pus every twenty-four hours, and her general condition was poor.

Bronchoscopy with a 7 mm. tube showed pus pouring out of the bronchoscopic tube; all the pus having been sucked out, the left bronchus was entered. There was an edematous bronchial stenosis of the upper lobe orifice with a small opening from which free pus was expelled with each cough; in addition, a membranous plaque was present which also obstructed drainage from the upper lobe. The long slanting end of the 7 mm. tube was gently introduced into the mouth of the upper lobe orifice separating the edematous stricture; the membranous plaque was removed by suction. After evacuating as well as possible the upper lobe branch, the lower lobe branches were examined but no pus was found in same. The upper lobe branch was again entered and the patient instructed to cough; with each expulsive cough there would be a gush of pus from this branch. The bronchus was apparently draining much more freely since the edematous stricture had been opened. With a 10 inch vacuum the bronchus was once more aspirated and after fifteen minutes the bronchoscopic tube removed.

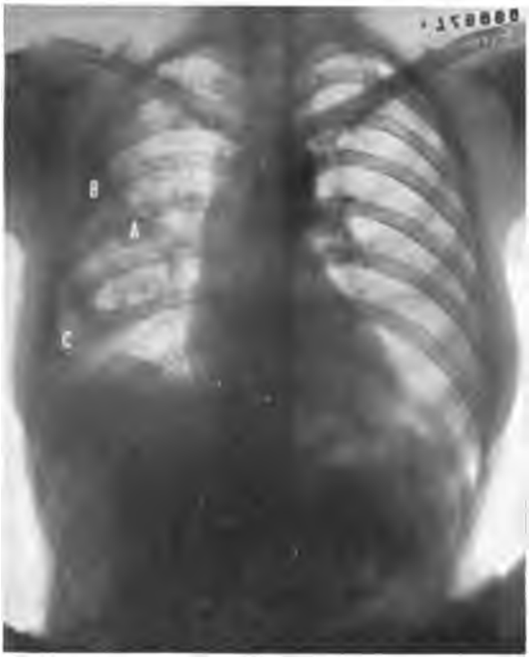

FIG. 7. CASE III. BRONCHIECTASIS BEFORE INJECTION. A. Area of diseased lung with faint evidence of cavitation. B. Resected ribs. Thickened pleura. C. Thickened pleura right diaphragm "hooked up" with adhesions.

The following week the patient had improved somewhat, but the amount of pus had not greatly decreased.

Dr. Lynah again bronchoscopically aspirated the upper lobe branch, and then decided to inject the bismuth and oil mixture in order to map out roentgenographically the abscess cavity. With the curved spiral cannula, 8 c.c. of bismuth subcarbonate in olive oil was injected too forcibly, so that some of it squirted out of the spiral and passed downward into the lower lobe branches (leakage out of the spiral will not occur if the bismuth is injected slowly, nor will it infiltrate the lobular structures of the lung). The upper lobe branches of the lung abscess were also injected, the bismuth sticking to the wall of the cavity and thus marking it out. Several smaller abscesses were now noted, whereas in the plate before injection the cavity was interpreted as being very large. The bismuth mixture did not infiltrate the lobular structures in the upper lobe. Stereoscopic plates showed the abscess cavities well anterior and out toward the periphery, while the mass, which had leaked down into the lower lobe branches, was well posterior. A lateral plate taken at this time showed the relations of the upper anterior lobe abscess cavity, which was clearly defined, to the posterior dull opaque fan-shaped areas due to gravitation into the dorsal branch.

The bismuth was expelled from the lung, as in the other patient, within twenty minutes after the injection. As some of the bismuth had leaked downward into the lower lobe branches, it was impossible to state whether or not the bismuth started immediately to be expelled outward, as in the first patient, or whether it had gravitated into the lower lobe branches after it started to be expelled.

The patient was studied from time to time with the fluoroscopic screen and further roentgenograms taken. At the end of one week there was still bismuth present, both in the abscess cavity and in the lower lobe of the lung where no abscess existed; this looked somewhat like an abscess cavity, but was seen roentgenographically as an irregular area of opaque dullness, and did not have the metallic luster of the bismuth in the abscess; this is one of the distinguishing points between infiltration of bismuth into the lobular structure of the lung and bismuth in an abscess cavity.

The patient improved after the injection,

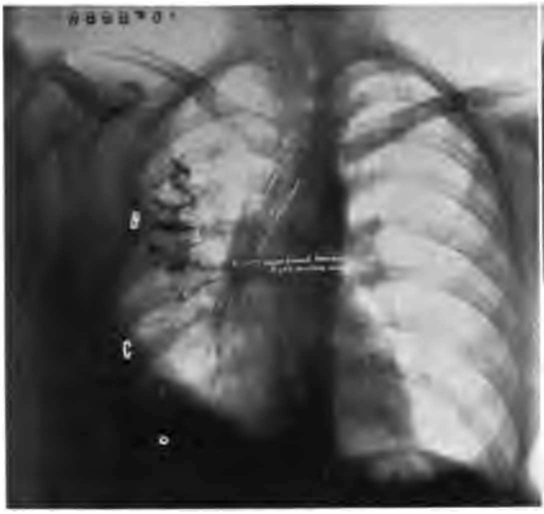

Fig. 8. Case iii. Bronchiectasis Immediately after Injection. A. Cavities mapped out with bismuth suspended in sweet oil. B. Resected ribs. Thickened pleura. C. Thickened pleura. Right diaphragm "hooked up" with adhesions.

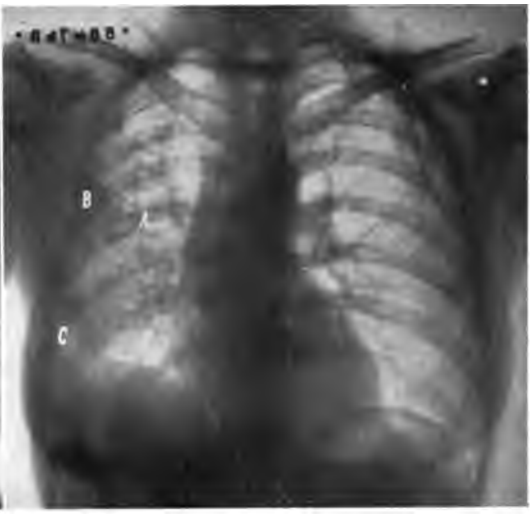

Fig. 9. Case iii. Bronchiectasis Six Weeks After Injection. A. Involved area of lung free from bismuth. B. Resected ribs. Thickened pleura. C. Thickened pleura, diaphragm caught in mass of adhesions.

in a manner similar to Case I. The pus decreased from her lung, and the amount of measured sputum in twenty-four hours decreased from 250 c.c. to 30 c.c. The odor was decidedly less and the patient's general health improved.

Bismuth was still present in the lung when fluoroscoped ten days after injection, although both shadows were diminishing in density and the lung abscess was apparently clearing up.

The patient suffered no discomforts following two injections of bismuth into her lung. She ate and slept well and had but little cough. She was bronchoscoped twice after the injection and we were not able to recover any of the bismuth by suction, even though it was still present in the lung. At a later bronchoscopic examination there was very little pus recovered by suction and no pus was expelled from the bronchus when the patient was instructed to cough.

The patient is still under observation.

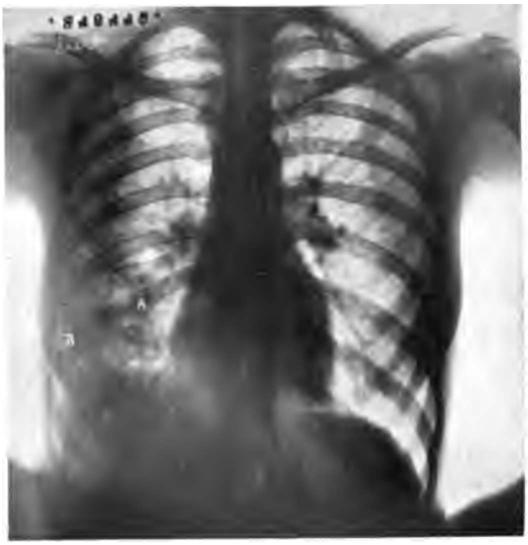

Fig. 10. Case iv. Bronchiectasis. Before Injection. A. Area of cavitation. B. Fixed diaphragm with thickened pleura and bands of adhesions.

Case III. A female, S. M., age twenty-five years. On March 26, 1918, she had her tonsils and adenoids removed. Ten days following the operation the patient began coughing up small quantities of foul-smelling sputum, thick and yellowish in character; the amount gradually increased and occasionally the sputum was streaked with blood. There was pain and soreness in the lower part of the chest.

She was operated in May, 1919. Rib resection was performed and the cavity Dakinized; no abscess was found. The following September the incision was reopened and the tube placed in the cavity; there was no drainage; very little improvement occurred. In November, 1919, a new incision was made lower down with resection of a rib; a tube was left in the cavity, but no drainage occurred. In January, 1920, the incision was reopened and extended backward. An abscess was opened and a tube left in for drainage, which amounted to four ounces on the first day and two ounces on the second day. The discharge gradually decreased, the tube was removed and the wound healed.

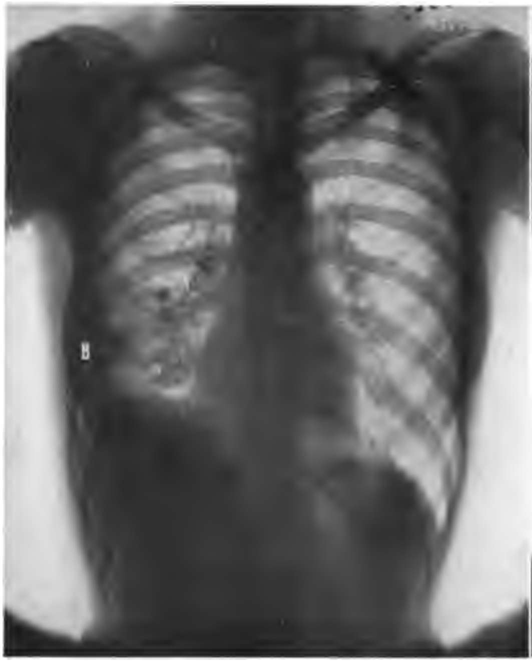

FIG. 11. CASE IV. BRONCHIECTASIS. IMMEDIATELY AFTER INJECTION. A. Area of cavitation outlined with bismuth suspended in sweet oil. B. Thickened pleura with adhesions. Right diaphragm "hooked up" and fixed.

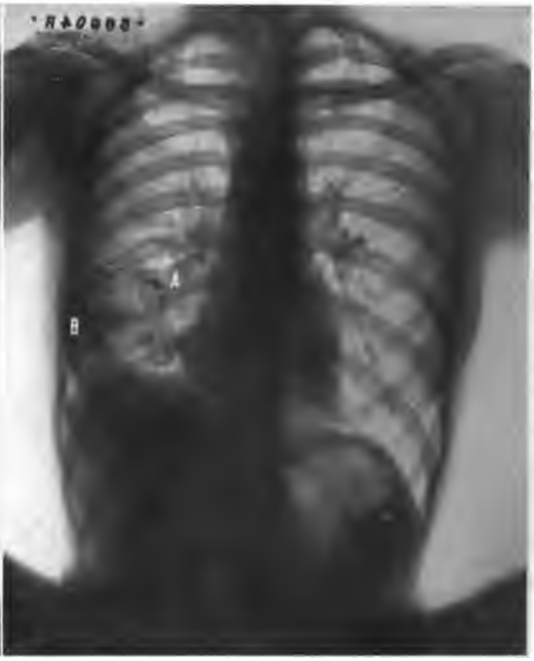

FIG. 12. CASE IV. BRONCHIECTASIS. FOUR MONTHS AFTER INJECTION. A. Area of cavitation. Small amount of bismuth still present. B. Some clearing of lung at right base. Thickened pleura with adhesions. Right diaphragm "hooked up" and fixed.

About six weeks later she began coughing and raising foul-smelling sputum again and gradually became worse until she was admitted to the Lenox Hill Hospital on May 17, 1920.

On May 22, 1920, a preliminary fluoroscopic combined with stereo-roentgenographic examination showed evidence of pleuritic thickening involving the upper and middle lobes on the right side; the right diaphragm was partially fixed with adhesions. In the lower portion of the upper right and the upper portion of the middle right lobes there was increased density with here and there evidence of cavitation.

The patient was bronchoscoped on May 25, 1920. Abundant purulent secretion was discharging from the upper lobe; 8 c.c. of a mixture of bismuth subcarbonate in sterile olive oil (1–2) was injected in the upper lobe bronchus; this was followed by a fluoroscopic as well as a stereo-roentgenographic examination which showed that some of the bismuth mixture had reached the diseased area, but not sufficient to map out the cavities satisfactorily.

A roentgen re-examination on June 9th showed much the same condition as reported on May 22d. Most of the bismuth had disappeared.

On July 8th the patient was again bronchoscoped, the main upper lobe being injected as previously. The stereo-roentgenograms, taken almost immediately after the injection, showed with excellent detail the numerous cavities in the lower portion of the upper and the upper portion of the middle right lobes.

The patient is still under observation and shows continued improvement.

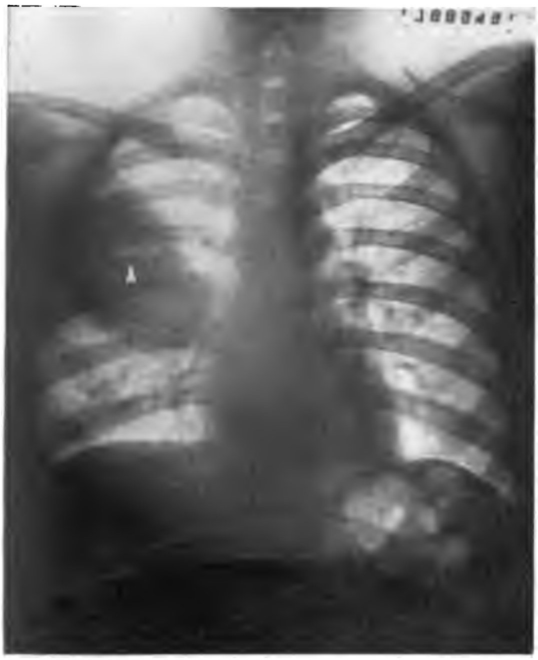

Fig. 13. Case v. Lung Abscess. One Month Before Injection. A. Lung abscess showing fluid level with air bubble above cavity surrounded by pus-soaked infiltrated area of lung structure.

Case IV. A. L., a young girl twenty years old, was admitted to the Lenox Hill Hospital in June, 1920, with the following history:

Tonsils had been removed two years previously. Following the operation she was taken home in an open car, with considerable exposure. Pneumonia developed; the cough continued, and two weeks later she began expectorating large quantities of foul smelling pus. This condition persisted up to the time of her admission to the hospital.

A preliminary fluoroscopic combined with stereo-roentgenographic examination, on June 19, 1920, showed marked pleuritic thickening over the middle and lower right lobe; the right diaphragm was "hooked up" with adhesions and there was considerable increased density in the middle and lower right with evidence of cavitation, especially in the lower lobe.

June 20, 1920, bronchoscopic examination showed pus coming from the middle and lower right lobes; none from the upper. A mixture of 8 c.c. of bismuth subcarbonate in sterilized olive oil was injected into the bronchi of the middle and lower right.

Roentgen examination, made as soon as possible after the injection, showed the bronchi within the diseased area well outlined, with numerous cavities clearly demonstrated.

When the patient entered the hospital she expectorated 300 to 500 c.c. per day. Since the injection gradual improvement has occurred with marked diminution in the quantity of expectoration.

The patient is still under observation.

Case V. E. E., male, age twenty-four years, entered the Lenox Hill Hospital on June 18, 1920, with following history:

Had tonsils removed June 5, 1920; six days later developed a cough which became productive on about the ninth day. On admittance his chief complaint was cough with expectoration, and pain in the joints.

June 23, 1920, a preliminary roentgen examination was made which revealed a dense triangular area in the lower portion of the upper right lobe; in the center of this pus-soaked, spongy area of infiltrated lung tissue, a fluid level with an air bubble above could be made out, indicating a large abscess.

On June 29th he was bronchoscoped, a 9 mm. tube being used. Pus was seen coming from the right upper lobe bronchus only. About 10 c.c. of bismuth subcarbonate in sterilized olive oil (1–2) was injected into the right upper bronchus; this was followed by roentgen examination which showed the lower bronchus outlined by the injection, very little if any having passed into the diseased area..

He was again bronchoscoped on July 8th. Pus was still obtained from the right upper bronchus which was again injected with bismuth suspension. Fluoroscopy and stereo-roentgenograms showed bismuth outlining the numerous cavities; some of the mixture had infiltrated into the lobular structures well out toward the periphery of the upper portion of the dense area.

The quantity of sputa gradually diminished until July 19th, when it had practically disappeared and the arthritic symptoms had greatly improved.

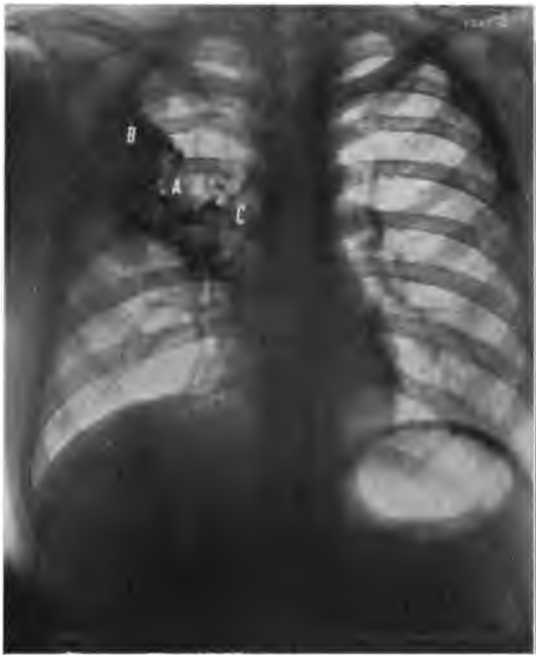

Fig. 14. Case v. Lung Abscess. Directly After Injection. A. Lung abscess mapped out with bismuth subcarbonate suspended in sweet oil. B. Bismuth infiltrated into lung structure.

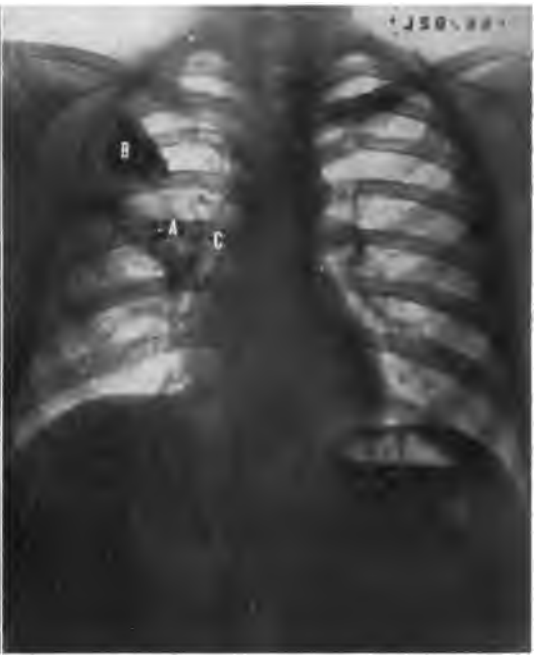

Fig. 15. Case v. Lung Abscess. Three Weeks After Injection. A. Remains of cavity. B. Bismuth infiltrated into lung structure. C. Dilated right bronchus.

A stereo-roentgenographic re-examination on July 26th showed gradual disappearance of the bismuth except where it had penetrated the lobular structures.

The patient is still under observation.

SUMMARY

1. Bismuth mixtures can be injected into the bronchi and lungs of a living patient without danger.

2. The injection of an opaque substance into the lung of the living patient will open an enormous field of usefulness in the study of cough, the expulsion of substances from the lung, and lung drainage. It will also aid in localizing bronchial strictures in the same manner as in the esophagus. Furthermore, it will be of the greatest aid to the thoracic surgeon by mapping out the abscess cavity in the respective lobe of the lung.

3. A definite lung abscess cavity is seldom seen bronchoscopically. Pus is usually seen coming from a branch bronchus, although the abscess may be well around the corner, and not in that portion of the lung from which the pus is oozing. An injection of bismuth mixture or some other opaque mixture will "clear up" this error.

4. Bismuth, when it enters the abscess cavity, is recognized by its metallic luster, whereas when it is in the lobular lung structure, it is discerned as a dull opaque area. Pus diffuses and soaks the lobular structure in a manner similar to bismuth; this often

makes the involved area appear many times larger than it really is.

5. The bismuth mixture injected in these patients was 8 c.c. of bismuth subcarbonate in pure olive oil (1–2). The mixture is rendered sterile by boiling before injection.

6. The injection should be made slowly and not with a "squirt," or else the roentgenographic observations may be spoiled by bismuth soaking the lung structure surrounding the diseased area.

7. It seems from these preliminary studies that cough and action of cilia are not the only means of expelling secretions.

8. While bismuth mixtures were originally injected for the purpose of lung mapping in cases of lung abscess cavities, they seem to have been of therapeutic benefit to the five patients upon whom they were tried. So far the procedure has done no harm.

9. While the fluoroscopic examination is important, stereo-roentgenographic examination is the best means of localizing the cavitations.

10. Experience has shown that the roentgen examination should be made almost immediately after the removal of the bronchoscope, otherwise the patient, in a fit of coughing, will remove much of the bismuth from the involved lung.

DISCUSSION

Dr. David R. Bowen. In the slide that was shown of Dr. Jackson's case the remarkable thing was that this plate was made on the fluoroscope with double screen. We hurried the patient to the stereoscope, and there was nothing there, although it could not have been more than fifteen minutes.

Dr. W. F. Manges. I should like to ask Dr. Stewart why he uses so much bismuth, why the mixture is so concentrated. This is a rather big field for study, and I wonder if it would not be well to advise a bit of caution. It seems to me that one should first be sure that he has the proper facilities for taking care of emergencies. Unless one has the association of a competent bronchoscopist, the procedure had better not be started. I think those of us who are in laboratories where there are efficient bronchoscopists, where there is every means for taking care of emergencies, ought to do everything we can to continue and work with Dr. Stewart alone these lines, and see if the end results are going to be right.

It seems to me that since a foreign body in the lung tissue must be removed sooner or later, for eventually the foreign body in the lung is apt to set up a suppurating process, I do not see why bismuth should not act as a foreign body in the lung tissue that has not been previously walled off by fibrous tissue—why it should not become a foreign body because of its metallic properties.

Dr. W. C. Hill. I should like to ask Dr. Stewart whether, in any of these cases where the bismuth was retained a month, there were any symptoms of bismuth poison, not nitrate poisoning, but bismuth poisoning. I know of two deaths from bismuth poisoning and I saw another case, a child, who was closely following the course of the others when I saw it, and advised evacuation of the bismuth.

Dr. G. E. Pfahler. I would like to compliment Dr. Stewart on his brilliant work, as well as the daring which led him to undertake it, but I would like to ask whether there is any benefit to the patient, or whether the benefits are purely diagnostic—whether the method has a therapeutic value to the patient other than simply to outline the abscess cavity for the benefit of the surgeon. We must, after all, consider how much good this is going to do the patient.

Dr. P. M. Hickey. I, too, would like to compliment Dr. Stewart on this pioneer work, and would like to take up the cudgel in its behalf. It is quite possible for a foreign body to remain in the lung without setting up irritation. I have two plates in the exhibit room—one a child who had a peanut in the lung for five weeks, and the other for two weeks. When I introduced the bronchoscope, there was no appearance of secretion. The bronchus was perfectly clear.

During this discussion, I have been thinking over some work I knew about some years ago, when a friend of mine injected the trachea and bronchi daily with a laryngeal syringe for chronic cough. The solution he used was olive oil and guaiacol. He used it in considerable quantities, and it seemed to be a soothing application.

If the bronchoscopy is done by a competent man, the injection of a small amount of sterile solution in the bronchus, I believe, can have no deleterious effects. It is certainly a very brilliant thing to be able to map out the bronchi in the way it has been done. It would, of course, be easier to collapse the lung and get rid of the abscess in that way, but this new method is important in that one is able to demonstrate in these cases the exact extent of the pathology present. It seems to me that, from a theoretical standpoint, there can be no danger to the patient, inasmuch as you use only a local anesthetic.

Dr. F. F. Borzell. It seems to me that there is considerable weight to Dr. Manges' statements. It might be true that when the bismuth is first injected, it is sterile; and I do not doubt that many of our foreign bodies which are inhaled are sterile at the time of inhalation; but with the bronchioles being constantly subjected to infection from without no foreign body would remain in the bronchiole for any length of time without becoming infected, resulting in the varied pathology one sees with any other infected foreign body in the bronchial system.

Dr. James T. Case. Are there any further discussions? If not, I should like to speak of my own experience in this matter. I have known of two deaths following the actual inspiration of barium-mixed food into the larynx, in one case the mixture being only barium and water. This was a case of carcinoma of the esophagus. One case I have especially in mind was one in which Dr. L. L. McArthur injected a bronchial cyst which had a pharyngeal opening. In the injection, a fairly large quantity of the bismuth mixture was used, the injection being done about five o'clock in the afternoon. During the night, the patient had a sudden fit of coughing. The next morning, she was brought to the x-ray room to see what had happened. The entire bronchial tree was distinctly filled with bismuth. Following this, the patient had a most violent case of multiple abscess of the lung, and it was a miracle that she lived through it; but she finally made a complete recovery.

Dr. W. H. Stewart. I expected, of course, a certain amount of criticism, and am very glad to have had the discussion entered into as it was. I always have a great regard for the opinion of Dr. Manges, as I believe he is one of the most conservative men in this particular line, and I have to voice his ideas, that it must not be taken up promiscuously, that the work must be done by an expert bronchoscopist, but it can be done absolutely without danger. It is really remarkable, gentlemen, that every one of the five cases reported this evening, wrote Dr. Lynah and asked for a re-examination, because they had received so much benefit from the bismuth injection. There is no question of the therapeutic value of this procedure to the patient. In one case the amount of expectoration was reduced from 500 c.c. in twenty-four hours to 30 c.c. in twenty-four hours. Whether or not a cure will be effected, we are unable to say at the present time, nor are we able to say whether the bismuth which infiltrated the lung structures will cause any further trouble. It has not up to the present; it is gradually disappearing and does not seem to act as a foreign body. I believe it will gradually disappear without any inconvenience. We have observed these cases for only six months; all are under close observation, however, and will be watched carefully.

In regard to the opaque solution—Dr. Lynah tried thorium and other mixtures of like character. He found that bismuth subcarbonate and sweet-oil was *the one* non-irritating mixture; it does not seem to trouble the patient in the least.

Dr. Hill asked regarding bismuth poisoning. I can emphatically state that never, in any way, has there been any evidence whatsoever of bismuth poisoning. As stated before, the patients were all benefited to such an extent that each and every one wrote a letter asking to come back to the Hospital for another injection.

With regard to the benefit to the patient, as asked by Dr. Pfahler, there seemed first to be the diagnostic element, and second, the therapeutic effect. Dr. Lynah questions in his own mind whether the benefit is due to the bismuth in the lung or whether to the fact that the bronchoscopy opened up the bronchi and allowed a free drainage of the lung. At the present time I believe both elements enter into it. Dr. Borzell, I think I have answered in regard to the retention.

With regard to Dr. Case's experience, it is impossible for me to say why this case should have such untoward effects. It may be that the injection was not made with the same precautions which Dr. Lynah uses in making his injections.

I am very sorry that Dr. Lynah is not here. He is a brilliant speaker, and would be better able to defend his position than I, who only take up the *x*-ray side of the question.

THE BUCKY DIAPHRAGM PRINCIPLE APPLIED TO RADIOGRAPHY OF THE SPINE*

By H. E. POTTER, M.D.

CHICAGO, ILLINOIS

MY object in presenting this short paper on radiography of the spine is not for the sake of reviewing the well-known pathologic conditions in which *x*-rays have proven of diagnostic value, or of calling attention to their differential features, but to set before you for your criticism a series of technical results made by a method with which you are familiar in theory but which, as far as I am able to learn, has not been used in a practical routine manner outside of our laboratory.

Those who are not familiar with the work we have been trying to do in adapting the Bucky diaphragm principle to practical radiography may be referred to the article published in the June number of our Journal. This takes up the construction of a parallel grid which moves between patient and plate during an exposure and serves to absorb a large number of the obnoxious scattered rays, while its simple movement serves to neutralize its own shadow. Attention was called to the larger number of scattered rays present in penetrating the deeper portions of the body, such as the abdominal or pelvic region. For this reason, in combination with one other, we have chosen to exemplify first the results obtainable in radiography of the spine. The other reason is that with crude apparatus of our own construction the element of time in grid movement has prevented the extremely rapid exposures desired in working with the moving viscera. We may say that since February of this year all

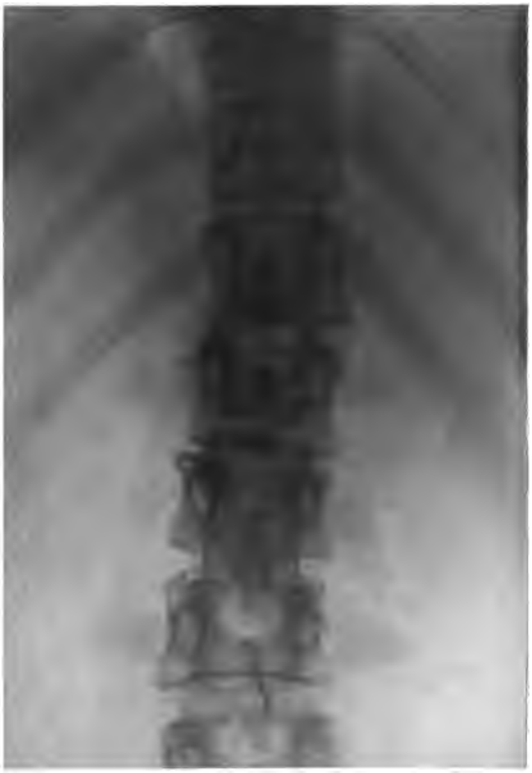

Fig. 1. Fractured Lamina of First Lumbar. Compression of Second.

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*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14–17, 1920.

our spine cases have been handled by this method, and in the last months all of the kidney and gall-bladder cases.

The net results of the method are to give us plates which show a heightened contrast between bony and other structures, and a greater clearness in the more delicate structures of the spine complex in as large a section of the spine as is desired. It necessarily follows that the gross lesions can be studied more comprehensively and the minor or beginning lesions brought to light with greater certainty. In the latter years we have all become used to seeing the most critical radiographs of the extremity bones, and we shall all admit, when we stop to think, that in the most important spine cases the diagnosis is often made possible by the last 10 or 20 per cent in the technical excellence of the plates. We believe that shortly the Bucky diaphragm method will form a basis for obtaining results on the spine which are entirely comparable to those obtained on the extremities, and at this time we wish to record systematically a number of respects in which the method has materially helped us in our diagnostic efforts:

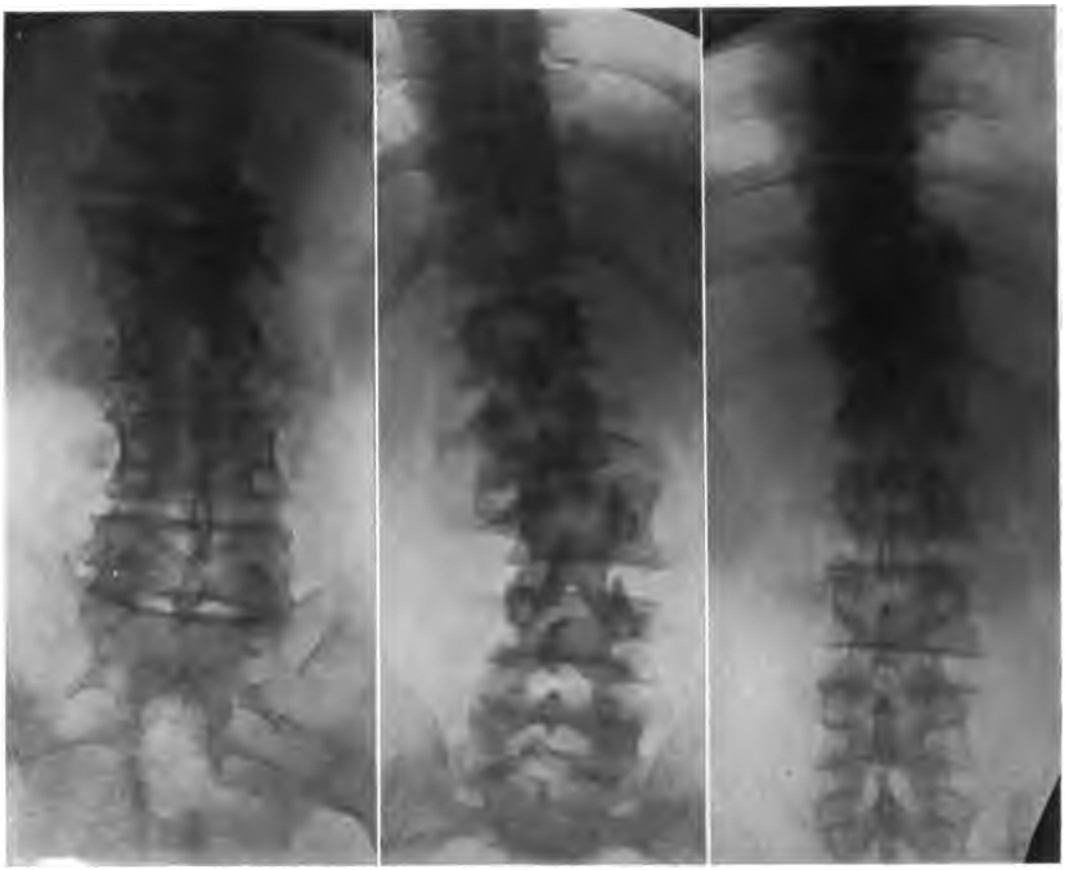

Fig. 2. A Few Fractured Spines Showing Large Scope of Exploration without Sacrifice of Radiographic Quality.

1. In the recognition of tuberculosis and metastatic carcinoma. Early tuberculosis and beginning metastasis are deservedly subjects which give the roentgenologist great concern on account of their clinical significance and general difficulty of recognition. The large comprehensive plates have more than once yielded unexpected information a few inches higher or lower than was clinically suspected. Slight or suspicious changes in any anterior portion of the vertebral body

have been followed up by plates projected obliquely or laterally so as to bring the suspicious point into profile, with the result that the suspicion was turned into a diagnosis.

2. This ability to obtain critical plates in oblique or lateral positions has many times resulted in the graphic measurement of slight impactions to the bodies of vertebrae where such could scarcely be known to exist by any simple or stereoscopic series made from in front. The general value of lateral spines has been brought out in this Society by Hickey and others. The Bucky diaphragm method offers us the easiest means of obtaining results in this most difficult technique.

3. This filtering method makes possible much more critical study of antero-posterior plates of the middle and lower dorsal vertebrae. Vertebrae lying above the diaphragmatic line have a peculiar anatomic relationship, in that on either side the air-filled lungs easily transmit rays which flood into the central plate area before the denser spinal structures have been fully recorded. It was one of our surprises to see how the plates with the Bucky apparatus prevented this source of fog and gave us the same clean results obtainable elsewhere.

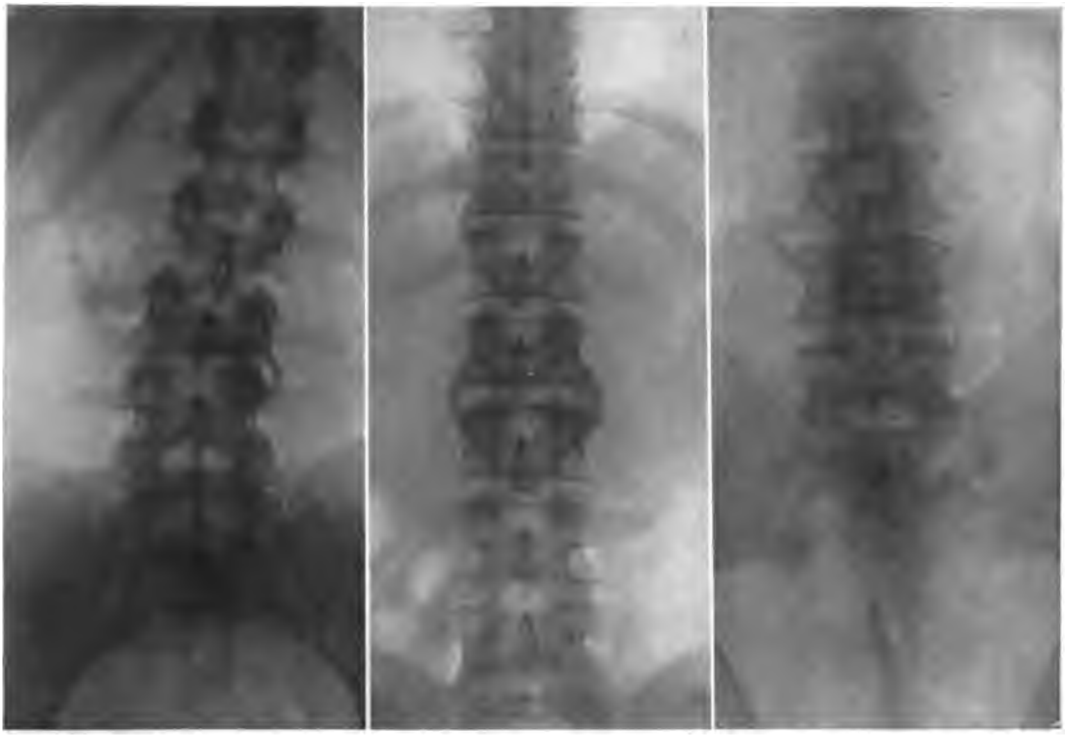
A B C

FIG. 3. DEEP OSSEOUS RADIOGRAPHY FOR DISEASE.
A. Tuberculosis with Bony Reaction. B. Typhoid Spine, after eight months. C. Metastatic carcinoma of prostatic origin. Hypertrophic Arthritis.

4. In the study of the pelvic structures the method has been gratifying on account of our ability to obtain a comprehensive plate of the whole pelvis without losing the details about either the hip-joints or the sacro-iliac region. Fractures of one portion of the pelvic ring are so often associated with a second fracture elsewhere in the pelvis that comprehensive plates should be re-

lied upon for the whole of the truth, particularly if radiographic detail can thus be preserved.

5. In cases of old minor injuries to the lumbar spine, associated with traumatic or other arthritis, or with callus formation, when structures of the pedicle and not the bodies have been fractured, etc., nothing short of the most excellent plates by this or any other method can lead one to a justifiable diagnosis, fully protected and set aside from the anatomic architectural peculiarities common in the lower spine.

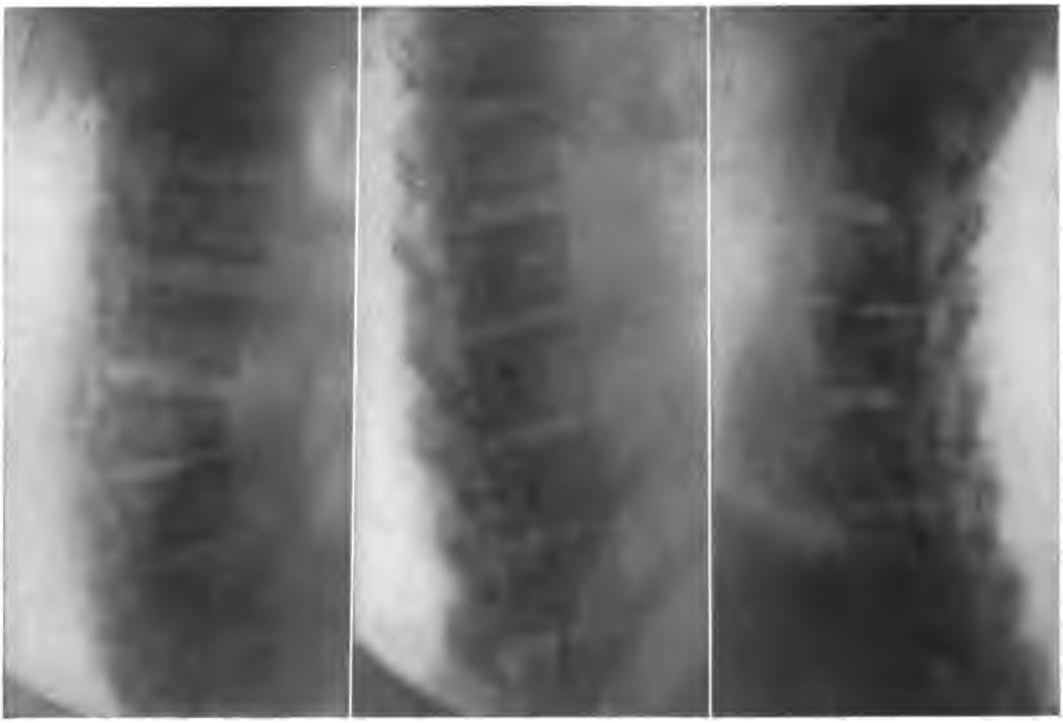
A B C

Fig. 4. A Few Lateral, Semi-Lateral or Near-Lateral Spines.

A. Lateral from Figure 3-A. B. Normal lateral for scope. C. True lateral in compression fracture.

These in brief are the advantages which we believe have been observable in our routine work. There is one disadvantage which can be seen in an inspection of any series of our plates. The osseous structures are slightly enlarged because of the increased distance between patient and plate, and when a large focus tube is used the hard lines lose somewhat of their sharpness. This disadvantage can be corrected somewhat by the use of fine focus Coolidge tubes, increasing the tube distance and using a grid of greater fineness and less depth.

DISCUSSION

Dr. B. C. Darling. The opportunity to make the large-sized plate seems to me is a distinct advantage. There has always been a limitation, for in order to get satisfactory plates, we had to use a small cone. By this method, we will be able to use more 11 x 14 and 14 x 17 plates, and we will get much finer detail by this method. The hardest thing to get is thus made easier, and in this way our diagnostic ability will be improved.

I had the pleasure of seeing this apparatus in Dr. Potter's office the other day, and he certainly has something worth while. He has something that, if mechanically perfected, will be of great value.

Dr. P. M. Hickey. Last summer I had the pleasure of visiting Dr. Potter's office, and seeing a demonstration of how this diaphragm works, and the plates which he has I have never seen equaled, either in number or quality. It is a wonderful thing that roentgenography of these parts of the body, which heretofore has been so difficult, can be brought out with such a wealth of detail.

Dr. Isaac Gerber. I would like to know whether Dr. Potter has found that the use of this diaphragm was interfered with at all in double screen and film work, or whether all of his exposures are made on straight plates or films.

Dr. H. E. Potter (Closing). The first exposures were made with plates entirely, and this seemed pretty hard on the thirty milliampere Coolidge tubes, so all the rest of the exposures have been made with double screen film, which is very much easier on the tube and simpler in technique. The double screen greatly aids instead of interferes with the method.

PNEUMOPERITONEUM AS AN AID IN THE DIFFERENTIAL DIAGNOSIS OF DISEASES OF THE LEFT HALF OF THE ABDOMEN*

By A. F. TYLER, B. Sc., M.D., F. A. C. P.

OMAHA, NEBRASKA

SINCE this paper is part of a symposium on the use of gas in the peritoneal cavity for diagnostic purposes, I am definitely limited in my discussion to the use of this method as an aid in the diagnosis of diseases of the left half of the abdomen.

Because of the fact that many cases complaining of vague symptoms on the left half of the abdomen present themselves for examination, it occurred to me when I began using this method of diagnosis that such aid might be of considerable use in clearing up this type of obscure cases, so that it has been my custom when I am unable definitely to locate pathology in the left half of the abdomen by the usual physical examination and the opaque meal examination of the gastro-intestinal tract, to employ pneumoperitoneum as a further method of investigation. We have been happily rewarded in many of these obscure cases, a few of which will be mentioned in the body of the present paper.

In reviewing my experience with pneumoperitoneum it has occurred to me that the greatest percentage of cases in which it has been definitely helpful have been those with some form of left-sided pathology. In order that we may lay proper foundation for pathological discussion, let us review for a moment the anatomy of the left half of the abdomen in relationship to findings demonstrable by penumoperitoneum. When the abdomen is filled with gas, it is possible to see clearly the outline of the diaphragm stretched across from the center to the left ribs and above this, of course, the lung in the chest cavity. Below it can easily be demonstrated that the spleen, and in many cases even the pedicle of the spleen, can be readily seen. Near the central portion of the left half of the abdomen can be seen the left kidney in toto. In some cases the left lobe of the liver can be visualized together with the tail of the pancreas. In other cases one will see a band extending across from the left parietal wall of the abdomen over toward the center, which is only the mesenteric attachment of the splenic flexure of the colon. One must be careful that this is not interpreted as pathological. Having these essential anatomical points in mind, it is then not difficult to determine what is pathological.

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*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14–17, 1920.

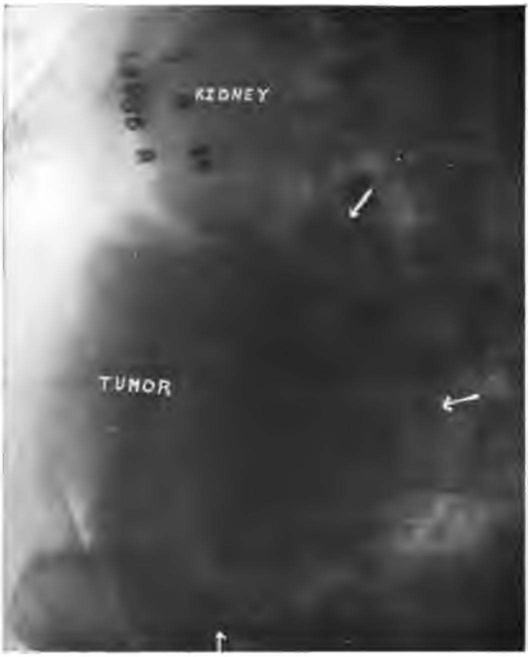

Fig. 1. Case No. 13965.—Large Retroperitoneal Tumor with Kidney Showing Above and Distinct from the Mass. Proven at operation to be sarcoma.

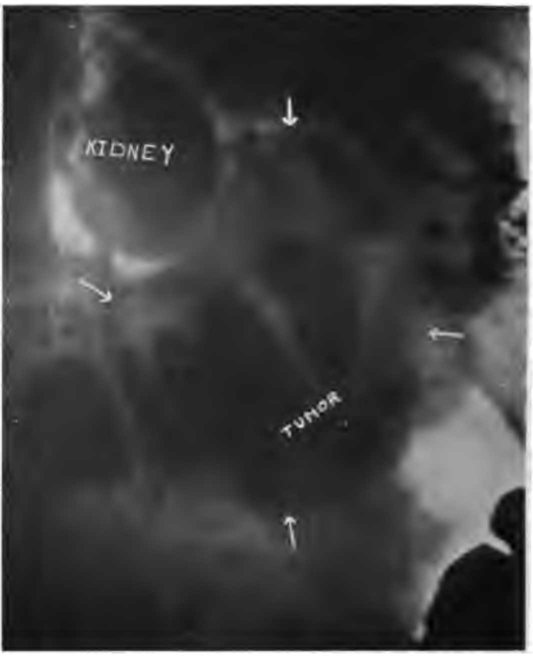

Fig. 2. Case No. 13965.—An Oblique View of the Same Patient as Shown in Figure 1, Showing the Kidney Separate from the Mass.

Patients frequently present themselves for examination complaining chiefly of colic in the left side which on investigation may prove to be renal or ureteral in type or perhaps colonic in origin. They will complain of an indefinite dragging or pulling sensation which is worse in the erect position and is relieved by lying on the back or on the left side. We are compelled in these cases then, to differentiate between diseases of the kidney, of the left colon, of the spleen, of the pancreas, of the left lobe of the liver and retroperitoneal new growth. In the colon we must differentiate between spastic or ulcerative colitis, adhesions, diverticula and new growths. In the kidney, we must differentiate between stone, pyelitis, tuberculosis, hydronephrosis, new growth, supernumerary kidney, ureteral plug or kink. In the spleen, we must differentiate between the different leukemias, enlargement from malaria, syphilis, hemolytic icterus or Banti's disease and perisplenic adhesions. In the pancreas we must differentiate between cyst and pancreatitis. The left lobe of the liver must be differentiated from the pancreas, the spleen and the kidney. We may further find adhesions of the various organs one to the other or to the parietal peritoneum. We may, in some cases, find a retroperitoneal new growth, such as a large retroperitoneal sarcoma recently demonstrated.

In speaking of the differential diagnosis in these various conditions, it is my thought that this differential diagnosis cannot be complete in any case without thorough physical examination, including the *x*-ray examination and the different laboratory tests, together with catheterization of the ureter and other methods usually employed for eliminating or confirming diagnosis; so that in my presentation of this subject, I take it for granted that all of these different methods are being employed along with pneumoperitoneum, as Case and others have shown that diverticula of the left half of the colon are not infrequent and when carefully searched for are quite readily demonstrated by the usual opaque meal and similar methods of examining the gastro-intestinal tract. As a rule the spastic or ulcerative colon can be demonstrated roentgenologically in the same manner. New growths in the left half of the colon are readily demonstrated by the opaque method. Stone in the left kidney is demonstrated without the use of pneumoperitoneum; but in some cases there is a question as to whether the shadow is really a kidney stone or a calcareous mesenteric gland, and pneumoperitoneum will help us to differentiate, especially when catheterization of the ureter is impossible. Hydronephrosis can readily be demonstrated by injection of gas into the peritoneal cavity, as well as new growths involving the kidney, or retroperitoneal space. Different types of enlarged spleen can be demonstrated by pneumoperitoneum, but must be differentiated by the complete blood count and different laboratory methods. Cysts of the pancreas can be positively proved by pneumoperitoneum better than by any other method. Adhesions to the various organs can be actually visualized by the injection of gas into the peritoneal cavity, clearing up many obscure cases.

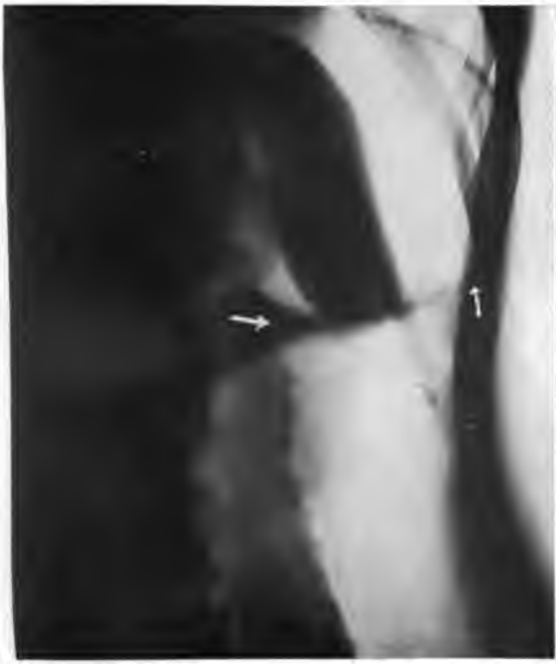

FIG. 3. CASE NO. 13285.—A DENSE BAND OF ADHESIONS STRETCHED ACROSS FROM THE COLON TO THE LEFT SIDE OF THE PARIETAL PERITONEUM. On inspiration, the spleen presses down against the band, as shown in the cut. On expiration the spleen moves away from it.

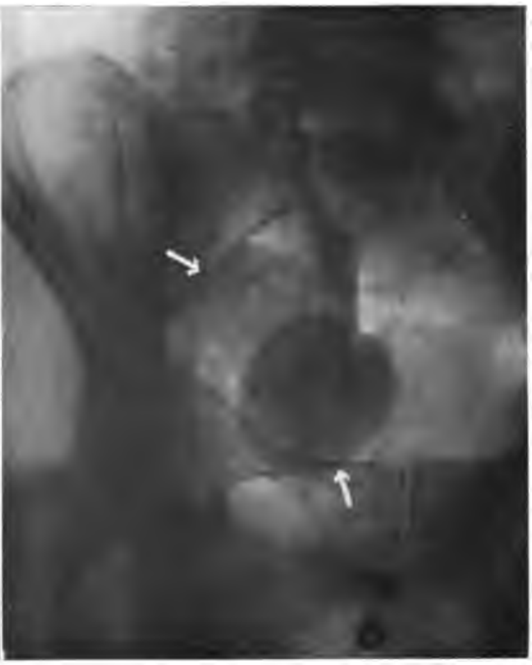

FIG. 4. CASE NO. 12880.—LARGE CYSTIC OVARY, ACCOMPANIED BY MULTIPLE FIBROID TUMORS OF THE UTERUS. PROVEN AT OPERATION.

CASES

CASE 13844: Mrs J. M. B., age thirty-three years.

History.—When the patient was twelve years old she had an attack of bilious fever with jaundice. For seven years she has had pain in the left upper quadrant of the abdomen, which radiates to the back and varies in intensity. She has abdominal distension with gaseous eructations, nausea, but no vomiting and no jaundice.

Physical Examination.—There was a palpable tender mass in the left upper quadrant of the abdomen and slight tenderness in the right upper quadrant.

Roentgen Examination.—This revealed a large soft tissue shadow in the left upper quadrant which has the contour of a kidney.

Pneumoperitoneum proves that the shadow is the left kidney, the spleen being normal in size. There are perisplenic adhesions from the spleen to the diaphragm. The stomach is normal in shape, size and position, empty in six hours. The duodenum is normal. The appendix has been previously removed. The cecum and colon are normal in contour, low, but freely movable.

Diagnosis.—Enlarged left kidney; perisplenic adhesions.

Case 13440: Miss A. D., age thirty-four years.

History.—For five years patient has been having attacks of abdominal distress, which usually last several weeks, characterized by a feeling of fullness or pressure in the epigastrium and in the left side of the abdomen, extending into the back.

Physical Examination revealed a definite tenderness in the lower right quadrant of the abdomen. Examination otherwise negative.

Roentgen Examination.—The stomach is normal in shape, size and position; empty in six hours. The duodenum shows spasm. The appendix has been previously removed. The cecum and colon are normal in contour and freely movable.

Pneumoperitoneum shows adhesions extending from the left parietal peritoneum across to the greater curvature of the stomach.

Diagnosis.—Perigastric adhesions involving the greater curvature.

Case 12846: Miss J. G., age twenty-four years.

History.—Patient complains of splashing in the stomach accompanied by pain and vomiting. She was examined by me in March, 1918, at which time a diagnosis of chronic appendicitis was made. This was followed immediately by an appendectomy. In July, 1918, a gastro-enterostomy was done. She has not been well since.

Physical Examination.—Patient was of the enteroptotic type. There was dullness in both apices of the lungs with râles in the left apex and left axilla.

Roentgen Examination shows the opaque meal passing through the gastro-enterostomy opening. The chest shows increase in both hila. Peri-bronchial infiltration well up in both apices. Multiple areas of consolidation in the left upper lobe.

Pneumoperitoneum shows a few adhesions to the abdominal wall at the scar. The shadows of both kidneys are visible. Folds of soft spleen, the uterus, tubes and ovaries are demonstrated.

Diagnosis.—Pulmonary tuberculosis. Abdominal adhesions.

Case 12355: Mrs. G. H., age forty-five years.

History.—Patient has been constipated for many years. For the past ten years she has had a tender point a little to the right and below the umbilicus. She now has constant pain which radiates to the right thigh and to the back, but it is never very severe.

Physical Examination.—Negative except for general abdominal tenderness with the maximum point one inch to the right of the umbilicus.

Roentgen Examination.—The stomach is normal in shape, size and position; eight ounce residue at five hours. The duodenum is normal. The cecum is not freely movable. The colon is normal and freely movable. The appendix is not visualized.

Pneumoperitoneum shows adhesions extending from the left side of the colon near the splenic flexure over to the parietal peritoneum near the costal arch.

Case 13346: Mrs. F. H., age twenty-nine years.

History.—One year ago the patient had her appendix removed. Two years prior to her operation she had indigestion and pain in the epigastrium with occasional vomiting. Since the operation, she has had a dull gnawing pain in the right upper quadrant. This pain is relieved by lying down. There is a feeling of fullness after meals.

Physical Examination shows marked tenderness in the right upper quadrant of the abdomen.

Roentgen Examination.—Filling defect on the lesser curve near the pylorus, probably spasm, no tender point; empty in five hours. The duodenum is normal.

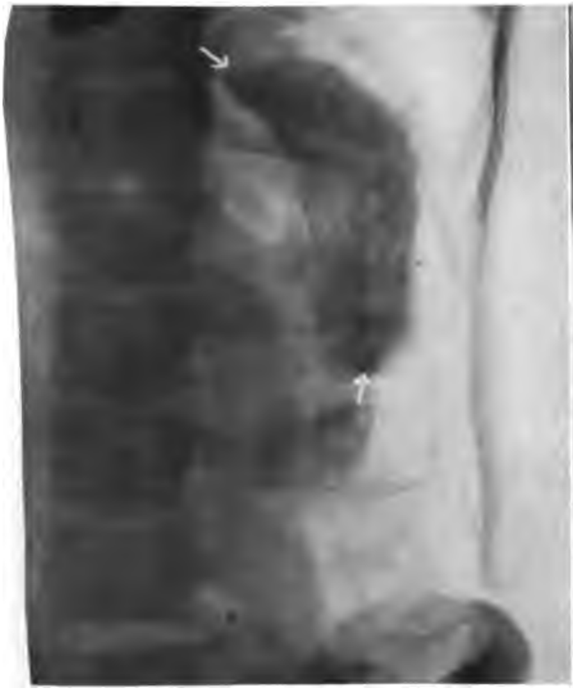

FIG. 5. CASE NO. 12846.—SPLEEN SHOWING TYPICAL FOLDS FREQUENTLY NOTICED AT POSTMORTEM EXAMINATION IN A SOFT FLABBY SPLEEN.

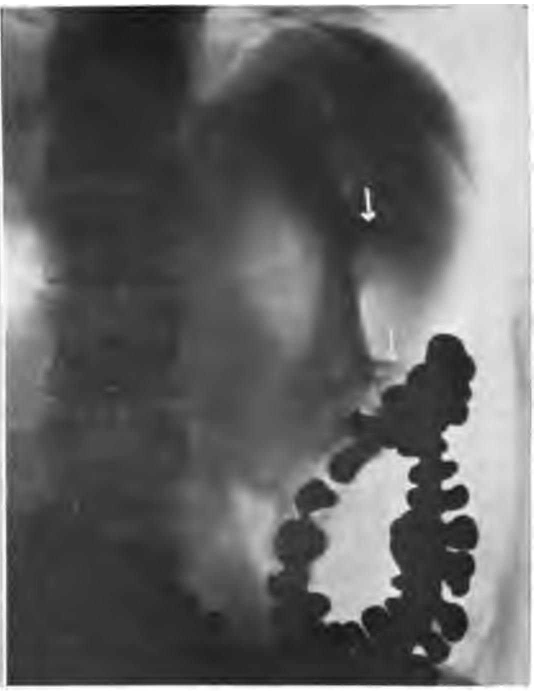

FIG. 6. CASE NO. 133440.—ARROWS POINT TO BANDS OF ADHESIONS EXTENDING ACROSS FROM THE GREATER CURVATURE OF THE STOMACH TO THE LEFT PARIETAL PERITONEUM.

Pneumoperitoneum shows a band of adhesions to the colon near the splenic flexure, against which the spleen is pressed on deep inspiration. A band of adhesions from the scar in the right iliac fossa to the head of the cecum is also demonstrated.

CASE 12973: Mrs. T. E. A., age forty-one years.

History.—Three months previous to examination the patient noticed that the abdomen was growing larger. This gradually increased until the time of the examination. At the time of the examination the enlargement extended up under the right ribs.

Physical Findings revealed a large uterus which nearly filled the entire abdomen. The mass was smooth except for several nodules on the upper anterior aspect.

Pneumoperitoneum shows a fibroid tumor of the uterus plus pregnancy. One month later: Fetus is not visualized, but fluid in the uterus is demonstrated.

CASE: Miss M. E. Age nineteen years.

History.—About two years ago patient began to have pain and swelling in feet and arms which was worse at night. She had a cough and pain in the chest, and night sweats once in a while. She was so weak at times that she could not walk upstairs.

Roentgen Examination.—Peribronchial infiltration well out in both lungs. Both sides of the diaphragm move freely.

Pneumoperitoneum shows the liver, both kidneys, tubes, uterus and left ovary normal in size and position. No abdominal adhesions. Cyst of the right ovary.

Diagnosis.—Cystic right ovary.

Case: Mr. J. C., age forty-nine years.

History.—About one year ago patient felt pain in left side and afterwards, due to curiosity, would feel his side and had pain on pressure. Later he felt a mass in the left side, which has continued to enlarge until its contour can be seen on inspection.

Physical Examination.—A large mass in the left upper quadrant of the abdomen which is painful to pressure and movable. Large tumor in the left side of the abdomen, clinically hydronephrosis. Large smooth mass extending beyond the median line to the right and continuous with the kidney shadow.

Pneumoperitoneum.—Movement of fluid in the sac visualized. Stone in left ureter just back of the bladder. Probably hydronephrosis.

Diagnosis.—Ureteral calculus.

Operative Findings.—Large retroperitoneal sac containing urine, attached to the lower pole of the left kidney which lay to the right of the median line. Ureter not connected to sac.

Case: Mr. J. H., age twenty-four years.

History.—Patient first noticed swelling of the abdomen accompanied by pain in the small of the back and around the umbilicus, especially at night when lying on his side. During the past week he has had a slight cough and two profuse night sweats.

Physical Examination.—Dullness of both apices posteriorly from the scapula down. Abdominal distention and umbilical hernia present.

Roentgen Examination.—A small amount of fluid in the left pleural cavity posteriorly.

Pneumoperitoneum showed adhesive peritonitis with ascites, probably tuberculous. Only a small amount of gas could be injected as the needle entered a pocket. The patient complained of pain when very little gas had been injected.

Diagnosis.—Tubercular peritonitis.

Case: Mr. P. S., age sixty-eight years.

History.—The patient had the prostate gland removed in 1918 and says stones were imbedded in it. He recovered from this operation and was in good condition for some time. Six months later he began having painful urination and passed large amounts of gravel and had colic pains in the urethra. He passed nearly one hundred stones through the urethra and had some removed from a pocket in the urethra apparently from a dilatation behind a stricture. He has lately noticed severe pain from a few minutes to a half hour after urination.

Pneumoperitoneum.—Patient could not pass catheter because of swollen urethra. One large bladder stone visualized and several smaller ones.

Diagnosis.—Recurrent stones in the bladder. Proved at operation.

Case: Mrs. C. E. R., age thirty-seven years.

History.—Three years previous the patient had a lump removed from the right breast and one year later a second operation was performed. She has been having attacks of pain in the right side for several years which she thought were pleurisy. The past two weeks she has been getting short of breath but has very little pain.

Physical Examination.—Left pleura markedly thickened. Friction rub on the right side at the junction of the sternum. Breath sounds diminished over the entire left chest.

Roentgen Examination.—Fibrosis with calcified glands extending well out in the right lung. Free excursion of the diaphragm, on the right side. The left lung is radiopaque below the level of the third rib anteriorly. Several round shadows one half inch in diameter are seen in both upper lobes.

Pneumoperitoneum.—Effusion of the left chest. Fluid in the peritoneal cavity which is easily demonstrated. No adhesions, no carcinoma masses demonstrable.

Diagnosis.—Peritoneal tuberculosis.

THE USE OF CO_2 IN PNEUMOPERITONEUM*

By WALTER C. ALVAREZ, M.D.

From the George Williams Hooper Foundation for Medical Research, University of California Medical School

SAN FRANCISCO, CALIFORNIA

A YEAR ago, when I began experimenting with pneumoperitoneum, it seemed to me that it would never come into general use unless some way were found of relieving the patient's discomfort immediately after the exposures were made. I felt that the technique would have to be modified in some way so that we could do the work in the office and not in the hospital. Some studies on the absorption of gas from the intestinal cavity had made me acquainted with the fact that CO_2 is absorbed much more rapidly than oxygen. In July, 1919, Dr. Taylor and I injected the preitoneal cavities of a number of rabbits with CO_2 and found that it was absorbed in a few minutes. After convincing ourselves that this gas was as harmless as oxygen we started using it on patients in the office. We found that whereas oxygen often remains in the abdomen in sufficient amounts to cause distress for four days after injection, the CO_2 in no instance remained over half an hour. Ordinarily the patient was relieved of tension in twenty-five minutes.

Dr. Stewart has stated in a recent article that he has tried to make the procedure suitable for office practice by withdrawing the gas through a trocar after the plates are taken. My experience with these patients makes me very doubtful whether many of them would be willing to submit to a second puncture while they are in pain. Moreover, I would rather not make another wound, although my experience with patients who have been operated upon after inflation is in accordance with that of others who have found no sign of damage. In only one case did I see a light strand of omentum adhering to the scar. Another objection to deflation is that it is hard to get all the gas out, and unless this is done completely the patient is going to remain uneasy.

TECHNIQUE

The introduction of the gas is simplicity itself. I use as a measuring bag the rubber cuff that comes with a sphygmomanometer. This holds about a liter. It is connected with the CO_2 tank and with the needle. The air in the tubing should be washed out with CO_2 because the nitrogen in it will remain in the abdomen for 10 days or more. No attempt need be made to sterilize the gas. The needle is sterilized and then thrust through a small spot which has been painted with iodine. I think there is no need for using novocain unless a very large trocar is employed. I use a needle with a caliber slightly larger than that of a lumbar puncture needle. I always clear it first by injecting a few drops of sterile salt solution. The injection is made generally at a point in the middle of the left rectus near the navel. I find it hard to get the patients to take enough of the gas. It is easy with old women who have lost weight and who have flaccid abdominal walls, but it is very hard with muscular men. I make it a routine to give a quarter of a grain of morphin a half hour before the injection. This unfortunately often produces nausea and vomiting later, but it seems the lesser of two evils because one never can tell which patients are going to complain bitterly. Even with the morphin, some do complain of pain, particularly in the right shoulder. Others do not complain of much pain but break out into a cold sweat and seem to be greatly distressed mentally. Others again have paid very little attention to the procedure, and one man got off the table and went out to lunch with me.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

I think the best evidence that the operation is not a terrible one is the fact that two of my patients, who did not take quite enough gas the first time, volunteered to have the work repeated.

The only disadvantage that I can see to the CO_2 technique is that one must work rapidly if a number of plates are to be secured. We almost always take first a 14 x 17 plate with the patient lying prone. This is developed immediately so that any special points of interest can be focused on in other plates. It is very helpful when the patient has not much gas in his abdomen to rotate him slightly so that the right side is a little higher for the gall-bladder plates and the left side a little higher for the spleen plates. In this way one makes the most of the gas that is there.

I made a few attempts to use mixtures of oxygen and CO_2, hoping that I might slow down the deflation somewhat, but I promptly gave this up because all the disadvantages of oxygen were retained without sufficient compensatory advantages from the CO_2.

Just a word as to the usefulness of the method. If it were not for the distress to the patient one would like to have a set of these beautiful and instructive plates on every individual who comes with intra-abdominal troubles. Unfortunately, however, the procedure is so alarming and distressing to many patients that I do not believe it can ever be used as a routine. I have found it of most help in the diagnosis of gall-bladder disease, especially in the early stages. I believe that daily we are slipping up on the diagnosis of early cholecystitis. We should be helping these people before they develop more definite symptoms, before they get stones and before they suffer irreparable damage to the liver and pancreas. One of the remarkable things about this technique is that it opens up a clear space between the liver and the kidney. Normally, the bowel should drop down out of this space; and in a number of cases in which it did not do that, operation showed the expected adhesions and the expected gall-bladder disease.

In this way I have been able to help a number of women who otherwise would have gone on suffering, because I would not have had the courage to advise operation in the absence of most of the classical signs of cholecystitis. Although some of the thickened gall-bladders without stones show up very clearly on these plates, it is most disappointing that others do not. I have here to-day a plate which fails to show any gall-bladder shadow although it does show a stone which gave symptoms for twenty-five years. To be sure, operation showed that the wall of the gall-bladder in this case was still thin. Moreover, in spite of repeated attacks of inflammation there were no adhesions to the colon. In other cases it was hard to be sure of the disease in the gall-bladder, even at operation. The wall was not definitely thickened, the bile was sterile, there were only a few adhesions to the duodenum and a large gland on the cystic duct. Nevertheless the pathologist reported small abscesses, full of bacteria, and the patient got well after the cholecystectomy. I think these observations must keep us humble, and must make us admit that the roentgen ray diagnosis of early cholecystitis will often be impossible and always difficult and uncertain.

In spite of these disappointments I still feel that the gas technique is going to be very useful. When the history and other findings point strongly to cholecystitis, and when a series of plates, taken in the usual way, leave the question undecided, I practically always resort now to this technique and often get a definite answer. For a while, after discovering the value of CO_2, I kept using O_2 for special cases; but the differences in the distress of the two groups of patients was so pronounced that I finally gave up the use of oxygen entirely. I think that others who compare the after effects of the two gases will come to the same conclusion, and that the use of CO_2 will win out, unless some one can find another gas which is absorbed in perhaps forty minutes. Even then, CO_2 might remain the gas of choice because it is cheap and a common article of commerce.

TRAUMATIC PNEUMOCRANIUM

By ALFRED S. DOYLE, M.D.

Assistant Roentgenologist, University Hospital. Roentgenologist to St. Agnes Hospital and
St. Edmond's Home for Crippled Children

PHILADELPHIA, PENNSYLVANIA

THE subject of traumatic pneumocranium is interesting inasmuch as only a few cases of this condition appear to have found their way into medical literature within the past decade. In THE AMERICAN JOURNAL OF ROENTGENOLOGY of December, 1913, Dr. W. H. Stewart of New York published what appears to be the first recognized case of abnormal intercranial air following fracture of the skull. It is interesting to note that while in the case reported by Dr. Stewart the air was on the right side and in the case which I am now reporting the air was on the left side, the condition was not suspected clinically in either case. In August, 1918, Dr. George W. Holmes of Boston published his case of air in the cranial cavity, and referred in his article to the cases reported by Dr. E. H. Skinner, Dr. W. H. Luckett, and one, not reported, by Walter Dodd.

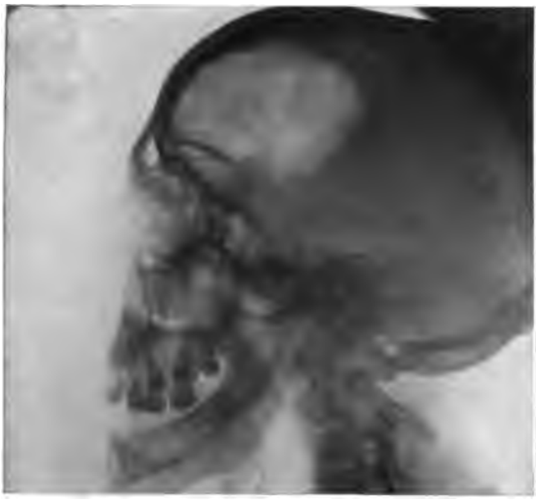

FIG. 1. LATERAL VIEW OF THE LEFT SIDE OF HEAD, showing air in cranial cavity displacing anterior portion of left hemisphere. The lines of the depressed fracture in the left frontal and temporal region are also shown extending down to the base. Note that the fracture does not show well through the air cavity, because of the over exposure in this area.

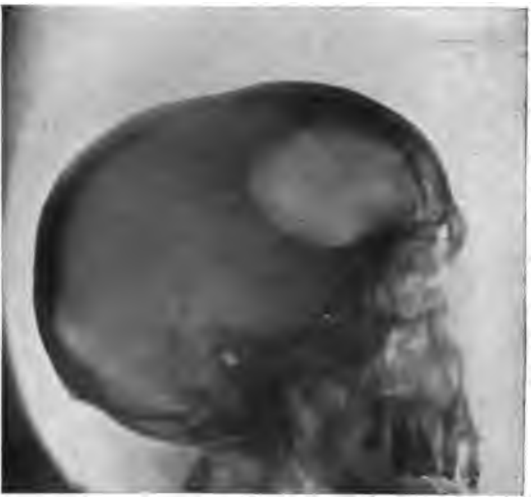

FIG. 2. LATERAL VIEW OF RIGHT SIDE. There is no difference in size of the cavity, as it extends to the midline of the skull.

In January, 1919, Dr. Hollis E. Potter of Chicago published a case in THE AMERICAN JOURNAL OF ROENTGENOLOGY and up to the present time that seems to be the only one on record in which the patient appears to have made a recovery either with or without surgical intervention. It is possible, however, that many cases of this condition presenting no clinical symptoms which would cause the patient to have an *x*-ray examination have passed unrecognized and made a complete recovery. The indication for operation would seem to depend entirely upon the symptoms, as is shown by the recovery of the case reported by Dr. Potter, in which the patient made a complete recovery without surgical interference, but at no time presented serious symptoms, and showed absorption taking place in subsequent examinations. In our case the patient presented symptoms which progressively grew worse until serious damage had been done to the frontal lobe of the brain and surgical intervention was evidently too late to save the patient. I have been unable to find any cases other than those referred to above with the exception of one reported by Dr. R. J. May of Cleveland and in THE AMERICAN JOURNAL OF ROENTGENOLOGY of April, 1919, in which case the plates were made several hours after death. The condition is somewhat unique in so far as it is not recognized or suspected until after the roentgen examination is made.

On June 7, 1919, the patient was struck by an automobile, at which time he received lacerations of the scalp in the supra-orbital region. He became unconscious and remained so for several days, and then regained consciousness, but complained of constant and severe headache in the left frontal region. He also complained of blindness in the left eye. The left eyeball was slightly sunken in the orbit. No operation was performed at the time beyond sewing up the wound. About the middle of August he became very irritable, but did not attempt violence either to himself or others. He also began to suffer from attacks of vertigo, and would faint three or four times a day.

About the latter part of August his mental condition became worse, and he developed auditory aphasia. When addressed he would frequently give a totally irrelevant reply. This condition became worse. His memory did not seem to be affected, for he had no difficulty in naming his nine children, stating their ages, dates of birth and death, and he seemed to be quite familiar with his circumstances and surroundings, and talked intelligently on topics of every-day interest. For some weeks previous to his admission to the wards of the University Hospital he would wet and soil his clothing, and claimed that he had no knowledge of having done so. He had evidently lost control over his bladder and rectal reflexes. His appetite was not affected and he slept well.

The patient was referred for roentgen examination September 2, 1919, and during the absence of Dr. Pancoast was examined by me. Stereoscopic plates were made of both sides of the head, also one postero-anterior of the frontal region, and one antero-posterior of the occipital region. The examination was made presumably to demonstrate a depressed fracture, which was found in the left frontal and temporal region. We were much surprised to find in addition a large air cavity. The plates of the left side (Fig. 1) showed the fracture involving the lower anterior section. The air cavity was oval in shape with irregular edges and measured 3½ by 2½ inches on the left side plate and about 2¼ inches in width on the plate made of the frontal region. (Fig. 3.)

Difficulty was encountered in obtaining the consent of relatives for the necessary operation; valuable time was lost, the patient gradually grew weaker, and the symptoms became more pronounced. Consent was finally obtained and operation performed September 24th. The skull was trephined in the left fronto-temporal region. The dura seemed tense and under pressure and upon opening it air rushed out with a hissing sound. It was found that the frontal lobe in this region was compressed by the confined air and the brain tissue was soft and lacked its normal resiliency. There was practically no bleeding and no evidence of previous hemorrhage. The dura was freed as far as possible from the skull to permit it to collapse and prevent the reforming of the air cavity. The condition of the patient rapidly grew worse and he died the next day.

The autopsy revealed two openings through the dura and a depressed fracture above the outer half of the orbit extending over to the temporal region in one direction and towards the cribriform plate of the ethmoid in the other. The brain tissue in the affected area was soft and did not expand after the air pressure had been released at operation. Brain tissue was adherent over the frontal sinus but no opening directly into the frontal sinus was found. The dura was adherent to the skull in many places, and the air was under the dura. The fracture extended into the ethmoid sinuses, into which a probe was passed, and found a free passage into the nasal cavity on the left side. Considerable thick mucous was found in the passage through which the probe passed. This probably acted as a valve in admitting and confining the air.

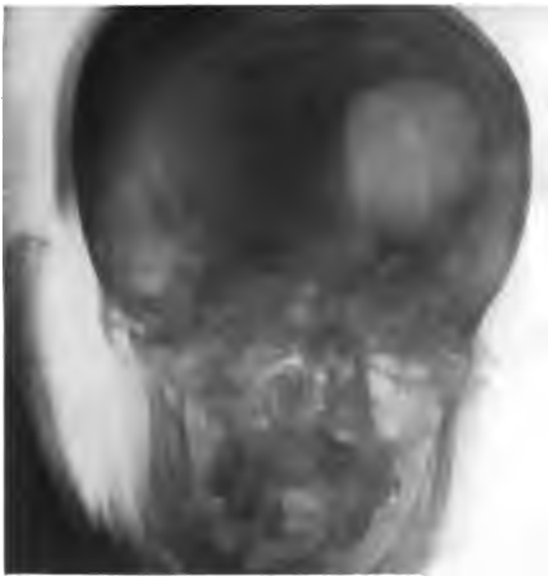

FIG. 3. POSTERO-ANTERIOR VIEW, PLATE ANTERIOR, showing the lateral dimensions of the air cavity.

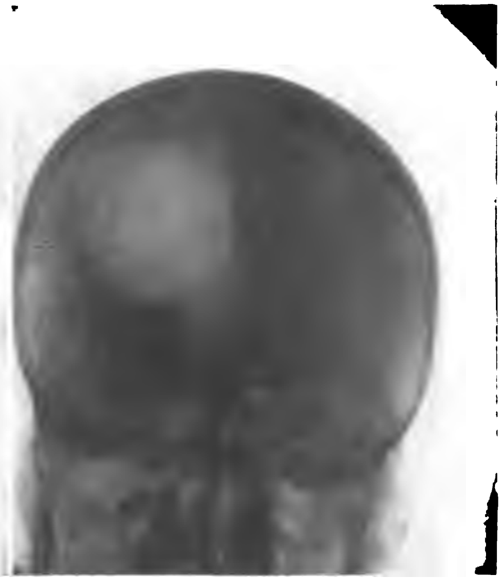

FIG. 4. ANTERO-POSTERIOR VIEW, PLATE POSTERIOR, showing limitation to left hemisphere.

The unusual features of this case were: (1) The length of time the patient lived with gradually increasing air cavity into which air constantly gained admission from the ethmoid cells and could not escape. (2) The condition was not suspected.

A RETINOMETER*

BY A. HOWARD PIRIE, M.D.

MONTREAL, CANADA

THE instrument which I present to you was made in order to allow me to test the sensitiveness of my own retina to the fluorescent screen. I use it for this purpose from time to time, but its chief field of usefulness is in its power to take up the attention of visiting physicians and surgeons who come to the fluoroscope with retinae rendered most insensitive by the light in which they are accustomed to work. These visitors to the fluoroscope are invariably willing to go on using the retinometer till they are ready to see the fluorescent screen to advantage. The more visitors who come at one time the better, as then there is competition between them as to who will first develop sufficient sensitiveness of his retina to be the first to use the instrument.

The retinometer consists of three luminous discs, the largest is a triangle, the medium sized one is oval and the smallest one is a circle with a diameter of about 1 mm. These three discs are kept in the dark by a covering flap which is kept in apposition with the discs by means of a spring. A string a yard long is attached to the flap. By pulling this string the discs are exposed. The free end of the string has a luminous tassel for the convenience of finding it in the dark. To use the instrument the observer picks up the tassel and pulls on the string; holding the tassel in his hand, keeping the string taut he places the tassel against his temple, his eyes are then at a distance of one yard from the instrument and the luminous discs are exposed to his view. He is now in a position to gauge the sensitiveness of his retinae. Most observers are able to see the luminous tassel at once. One who has come into the dark room from out of doors will be unable to see the large luminous triangle. But by going close up to it he will see it and he can then recede from it gradually, keeping it in view as his retina grows more sensitive. When he can just see the large triangle alone at the distance of the length of the string (one yard) he will be unable to see the next brightest spot—the oval, but by now going close up to it he will be able to see the oval and by the time he can see the oval at the distance of the length of the string, he is ready to begin to use the fluorescent screen. Until he can see the triangle and the oval in the dark his eyes are not in a fit state to look at the screen. It is folly to point out tuberculosis to a visiting physician when his eyes are not sensitive enough to see these two discs in the dark. Visitors to the dark room seldom stay long enough to be able to see the third luminous disc, but the radiologist should be able to see it plainly himself.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

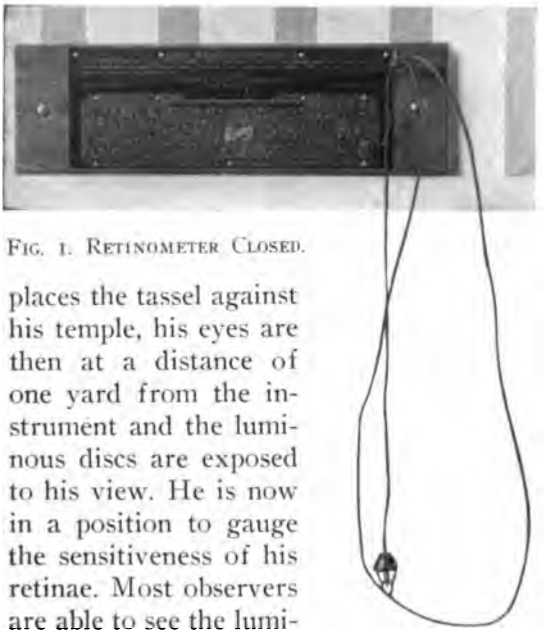

FIG. 1. RETINOMETER CLOSED.

When finished with the instrument the observer lets go of the string and it automatically closes, thus protecting the luminous discs from the action of light. The discs shine more brightly in the dark after being exposed to bright light and for this reason they are always kept in the dark and only exposed to view by the action of pulling the string. They remain of constant luminous power if they are not exposed to the light.

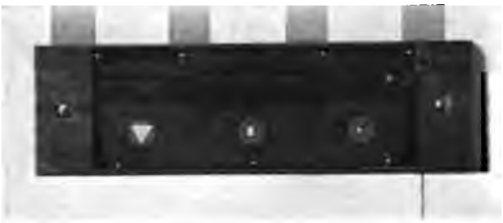

FIG. 2. RETINOMETER OPEN.

The three discs chosen for this instrument are the standard discs of a company manufacturing them. I picked them out of a large selection of standard luminous discs, and have been using them for more than six months during which I have noticed no change in the power of their luminosity.

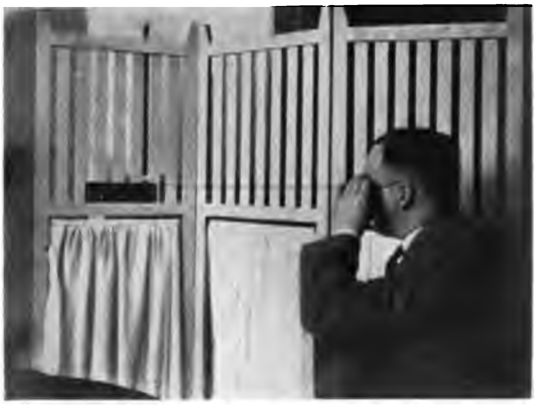

FIG. 3. RETINOMETER IN OPERATION.

I have to acknowledge the help of the Victor Electric Corporation in getting the instrument up in its present shape, which differs considerably from my first model.

INTRACRANIAL CALCIFICATION*

By JOHN T. MURPHY, M.D.

TOLEDO, OHIO

THIS paper is the result of an interest in the subject aroused by the following case:

CASE REPORT

Mrs. M. J. L. Referred by Dr. Pamment.

Occupation: Bookkeeper. Age forty-seven. Married.

Previous History.—Negative except for diphtheria in childhood. Perineal repair in 1912. Menstruation began at eighteen years. Stopped at the age of forty-two. Always regular and no pain. Patient married at twenty-four years and had her first child at twenty-seven years, which died fourteen months later of infantile paralysis.

Convulsions began some time after an operation for repair of a perineal tear, in 1912. At first they occurred about twice a year, then four times a year and during November, 1919, she had four. With two exceptions they always came on during sleep. Her husband states that he would be awakened in the early morning by her moaning and would find her shivering, teeth set and some frothing at the mouth. She would be unconscious of the attack until the next morning, when she would find that she had passed her urine in the bed, and had a sore tongue and a severe headache. She would feel so tired and muscle sore that she would not go to work that day. She has had more or less headache, but noticed that the headache was very severe and continuous the whole month of November, 1919. Has had no nausea or vomiting. Has worn glasses for some time but has not noticed that her eyesight was getting worse previous to this last attack.

Present Complaint.

1. Paralysis of right arm and leg.
2. Inability to speak.
3. Drooling from right side of the mouth.
4. Convulsions.
5. Headache.

History of Present Complaint.—On Nov. 29, 1919, patient got up at the usual time, dressed herself and went to the kitchen to prepare breakfast, but was not conscious of it. Her husband saw that she was not well and insisted that she go back to bed. He tried to have her drink some coffee but she couldn't hold the cup. He put her to bed where she slept almost continuously for twenty-four hours.

Physical Examination.—Nov. 30, 1919. Patient is a robust woman, lying in bed, conscious but unable to talk. Head and Neck: Right side of face is smoothed out. Tongue protrudes to the right. Mouth is drawn to left. Drools out of right side of mouth. Right eyelid closes partly only. Patient tries to talk but cannot. Chest: Lungs—negative. Heart: Borders normal, rate, 70, rhythm good. No murmurs. Abdomen: Negative. Right Arm: Can move it part way to head. Left Arm: Normal. Right Leg: Can move it slightly. Left Leg: Normal. Blood Pressure: Systolic, 130; Diastolic, 85. Blood Wassermann: Negative. Spinal Fluid: Negative. Urine: Negative.

Since this time there has been a gradual return of normal functions. No convulsions since onset. As soon as the patient was able to be about she was brought in for examination with the *x*-rays. A stereoscopic set of plates showed the following:

A series of fine calcified lines, each forming part of a circle, was seen to lie above and behind the sella and about midway between the left side of the skull and the median line, the whole making a barrel shaped shadow with the long diameter transverse, size about ½ inch in width by about ⅝ inches long. There is also a distinct increase in the markings of the frontal bones on that side.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

On reviewing the literature an exhaustive study of the subject was found in the *Johns Hopkins Hospital Bulletin* for October, 1916, in which the entire subject of the use of the *x*-ray in brain tumor cases was taken up. The previously reported cases are reviewed. They are seven in number, all from the foreign literature. To these are added six of their own, found in a series of 100 cases clinically demonstrated brain tumors.

In the cases reported in the foreign literature Fittig observed three calcified areas in the walls of a cyst in an occipital lobe; Grunmach a calcified tumor in the pineal gland; Algygi a basal tumor with areas of calcification; Klineberger a tumor of the occipito-parietal region; Steida a calcified cysticercus, and Sträter a calcified brain abscess only recognized after operation; Lichtheim a calcified gumma also not recognized until after operation. Schüller in his book reports five cases all of which are calcified areas in the brain substance itself. Huerig and Dandy's cases are as follows: One case of calcification of the brain substance, one case of calcification in the sella, one case of calcification extended from the base upward into the brain substance, one case of aneurysm of the internal carotid artery, and two cases of calcification above and very close to the sella.

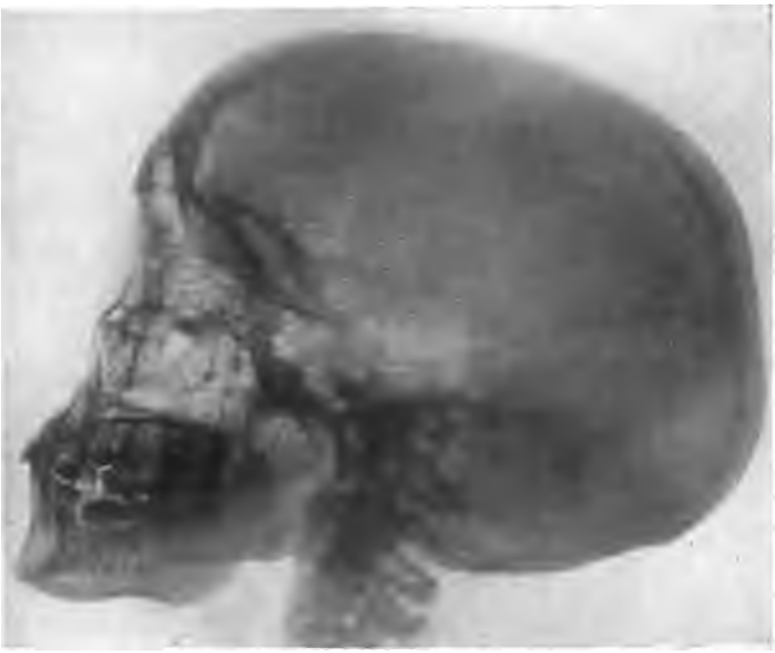

FIG. I. SHOWING CALCAREOUS MASS IN LEFT SIDE OF SKULL.

In THE AMERICAN JOURNAL OF ROENTGENOLOGY, 1916, III, is a report of a case by A. W. George, as follows: A man twenty-three years old. Stereoscopic plates of the head made in the lateral position show an area of about 3 cm. in diameter, posterior to the sella, with apparently calcified walls. The patient had been injured in the head while playing football and was unconscious. Epileptic attacks began about eighteen months ago. Operation showed a small tumor situated just below the pia mater and adherent to the midfrontal lobe, diagnosed as an encapsulated glioma.

In an endeavor to find out the general experience of roentgenologists, I wrote to twenty-five of the members of the Society, asking them to give me their experience with the demonstration of calcified areas within the skull. Many of the letters spoke of the calcification of the pineal gland, which was considered as a normal finding. Except in four instances the replies were negative for other findings. Dr. Charles F. Bowen reported one positive case in approximately 200 cases examined. The history is as follows:

There was a calcareous deposit about 1 inch long and ½ inch wide which was found to be lying just above the external auditory canal about 1 inch from the inner table. It was lying in the brain tissue. This was removed at operation and his epilepsy cured. The man had had a fractured skull about fifteen years before. Dr. Bowen was of the opinion that a small piece of bone was driven into the brain tissue acting as a nucleus for the deposit of lime. The specimen however failed to show any nucleus of this kind. This was the only case in the experience of these men in which they were able to show calcification in the brain itself. One man had had considerable experience with calcified areas in the falx cerebri, the "psammoma" of the textbooks. Two other men called attention to the finding of calcified plaques in the meninges. Other than this the findings had all been negative.

The actual diagnosis of the case I have reported is in no way clear to me. Whether it is a cyst of the brain or an aneurysm of the anterior cerebral artery I am not sure. It is however clear from the clinical view-point that its presence has at times caused changes in the internal capsule; the absence of general signs of pressure is noticeable, and although the eyegrounds were not examined at the time of the paralysis, later examination shows them to be clear.

Roentgenograms made recently of the case seem to show that the tumor is less clearly defined; this however may be due only to difference of technique. The fact that the patient has been on small doses of the iodides continuously since, may have had some effect. She now is apparently in good health, with no headaches and only a small facial paralysis remaining.

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DISCUSSION

Dr. W. F. Manges. I know but little about the subject of the author's paper. I have seen quite a number of calcified masses in the skull. I have not come to the point where I want to take the time to study the literature on the subject, and unfortunately the cases are so seldom operated, that we really don't get to the final diagnosis in the matter.

I have recently had a case in which there was a calcareous mass that was fully an inch and a half in length and practically an inch in its greatest width, irregular in outline, and very much more densely calcareous than is shown in Dr. Murphy's case. This particular patient had no symptoms whatever, except headache. He was a clothing salesman, who had been working up to within two or three days of the time when I first examined him, but he did have at that time very violent headache. He stayed around the Hospital for a while, and became dissatisfied about something and went elsewhere. Finally someone started giving him iodides—his Wassermann had been negative both by blood and spinal fluid—but with iodides his headache disappeared, and he was apparently very much improved. I haven't had a recent radiograph of him, so I can not say whether or not there has been any change in the tumor.

In another instance, an adult, man, age forty-five to forty-eight years, had been perfectly healthy all his life, without any history of injury until just shortly before my examination—I have, I believe, shown this case before this Society or some section of it previously—and the radiographs of the head showed a dense "stone," I called it, in his brain, within about a half inch of the cortex on one side. He came to me for examination because he had recently developed epileptic convulsions, never having had any during early life, and no family history of anything of the sort. What the origin of that density was, I haven't the faintest idea, but I think the injury he received shortly before he came to me was severe enough, and the weight of this thing sufficient, that the trauma that otherwise would not have been disastrous at all, set up an irritation which was the cause of his epilepsy. He refused operation.

Then again I have had a number of cases in which these calcareous nodules were multiple and scattered throughout the brain, near the cortex, and deep in the brain, and in only one instance did I have any idea as to what the cause might be, and that was the case of a child who gave a very definite history of tuberculous meningitis, and I thought perhaps there had been foci of infection in the brain at one time which had healed by calcareous deposit.

Dr. W. A. Evans. We have been able to classify intracranial calcifications under three general heads. The first is the calcification which occurs in cyst walls. These cysts have been observed both in infancy and adult life. Infants showing calcified cyst formation usually present evidence of impaired mental development or a spastic paraplegia. The calcifications occurring in adult skulls are usually associated with cysts which are secondary to a fracture of the skull or subdural hemorrhages. Plates of the head in a case recently referred for skull examination, with a history of epilepsy, revealed a calcification which occurred in the brain substance, the distribution of lime suggesting deep brain cyst.

Under the second heading are the deposits of so-called "brain sand." Of special interest at this time is the deposit of lime in the pineal body, it being claimed by some observers that the calcification of the pineal is evidence of its degeneration, with resulting loss of function; accordingly cases presenting abnormal sexual development should present atypical calcifications of the pineal gland. In our experience, there has been no constant connection between early deposits of lime in the pineal gland and precocious sexual development of thirteen, in which we were unable to show any brain sand in the vicinity of the pineal.

The deposits of brain sand in the falx cerebri, the so-called psammoma, should not be considered as the same type as a pineal calcification. Some pathologists classify them as a true bone tumor or osteoma.

Under the third heading, and this is probably the least important, is the calcium deposit in the walls of the blood vessels, especially the circle of Willis.

NEW ROENTGENOGRAPHIC TECHNIQUE FOR THE STUDY OF THE THYROID*

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

MY experience in the study of the thyroid roentgenographically, heretofore, has been generally unsatisfactory. I have seen no description of technique that really demonstrates the outline of the thyroid except in very large thyroids or in the large substernal thyroids. These have been studied in the postero-anterior position, especially by Drs. Crotti and Bowen in their excellent paper presented before this Society in 1913.[1]

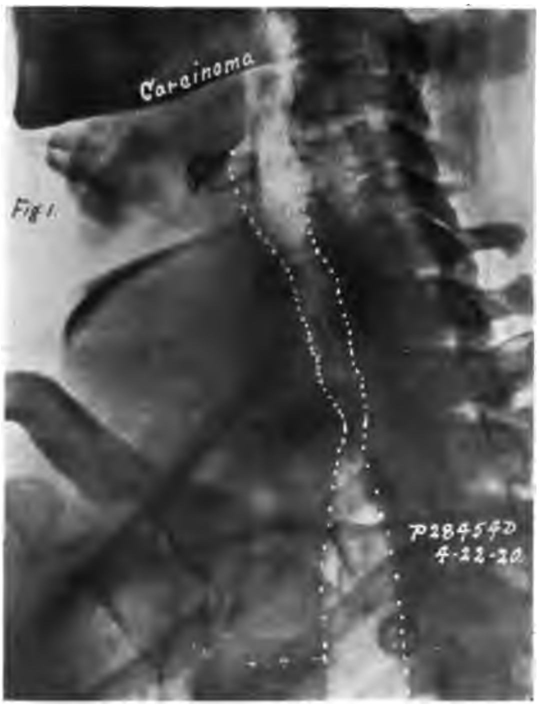

FIG. 1. P.24454-D. MR. J. S. CARCINOMA OF THE THYROID. Note the size of the thyroid, but particularly the irregular compression of the esophagus.

Since so large a number of the hyperthyroid cases are sent for roentgenotherapy, because of the excellent therapeutic results obtained in the treatment of toxic goiters, we have an excellent opportunity for a careful study of this group of patients. Therefore, in February of this year I determined to investigate these cases as thoroughly as possible roentgenographically, and have finally developed a technique that is almost universally satisfactory, because one can, by this method, demonstrate not only the abnormal thyroid and the enlarged thyroid, but the normal thyroid. I know of no other technique which will demonstrate the size and outline of the normal thyroid.

It is well known that the reduction in the thyroid by roentgenotherapy is one of the latest results obtained in the treatment of the exophthalmic goiters, or Grave's disease. I have many patients that have been cured, but unfortunately I do not have their original roentgenograms; that is, the roentgenograms made of their particular cases at the beginning of treatment. I am quite sure, however, that as this study is further developed and continued, we can record quite accurately the progressive reduction in the size of the goiter. Measurement of the circumference of the neck in determining the reduction of the goiter is very crude, for one may actually have a reduction in the size of the tumor, and yet an increase in the size of the neck, because it is quite well known that as exophthalmic goiter cases improve, they begin to take on weight. In fact, increase in weight is one of the earliest signs of improvement. As they increase in weight, naturally the circumference of the neck increases due to the deposit of fat, and therefore the goiter may be reduced while the circumference of the neck shows very little reduction or even shows an increase. It cannot, therefore, be depended upon as a method of recording the progressive reduction of a goiter.

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[1] CROTTI, ANDRE. The roentgen ray in intrathoracic goiter and thymus hyperplasia. *J. Am. M. Assn.*, Jan. 11, 1913, p. 117.

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

In a number of cases patients are sent with symptoms of hyperthyroidism and one can feel little or no enlargement of the thyroid, but since I have been using this method of recording, I have not found one in which there was not an actual enlargement of the thyroid. I cannot say, however, that one does not have hyperthyroidism without an increase in the size of the thyroid. Occasionally a patient complains of difficulty in swallowing due to pressure in the region of the thyroid and yet, by palpation, the enlargement is so slight (or entirely absent), that it is difficult to understand how a patient can have such symptoms without palpable enlargement. By this method, however, compression of the trachea or pressure of the esophagus can be shown and these symptoms explained. It is well known that even the very large goiters may cause no pressure effects on either the trachea or the esophagus. On the other hand, a very small goiter or small adenoma may press posteriorly and cause a very distinct symptom of pressure and difficulty in swallowing or breathing without being palpable.

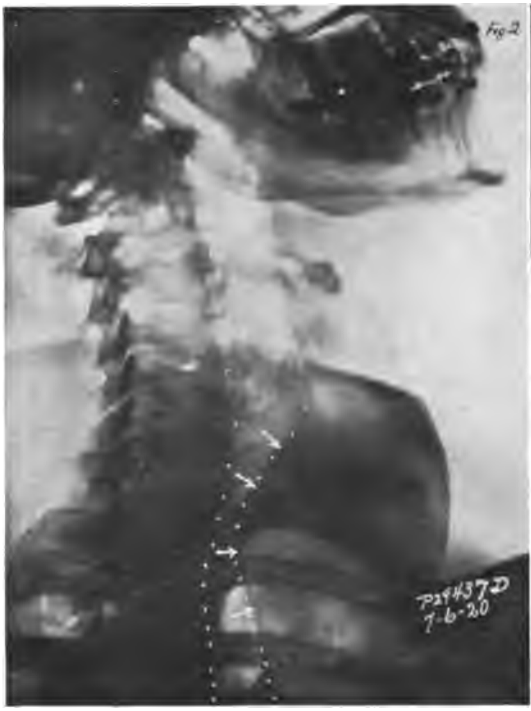

Fig. 2. P.29437-D. Moderate-Sized Goiter Showing Marked Compression of the Esophagus.

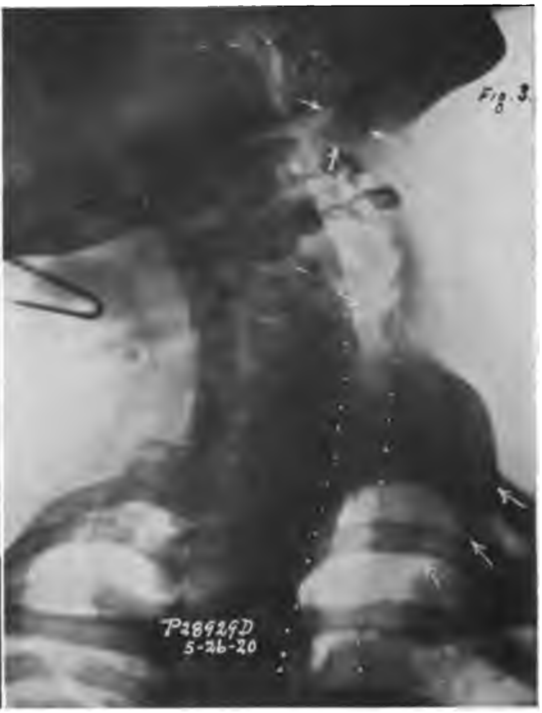

Fig. 3. P.28929-D. Note the Compression of the Esophagus by a very small Goiter in a Case in which the Goiter was not Palpable. Note the enlarged lymphatic gland under the angle of the jaw.

This method may be of value in differentiating malignant goiter from the benign goiter—probably only in occasional instances, however. In one case there was considerable irregularity in the outline of pressure upon the esophagus.

TECHNIQUE

The examination is made with the patient in the standing posture. The position best showing the outline of the tumor is obtained fluoroscopically. The patient's sternum and the anterior portion of the neck is pressed strongly against the fluorescent screen. The chin is turned toward the side on which the enlargement is most marked and tilted upward as far as possible. This draws the thyroid up into position where it can be shown in the plate. One's aim must be to get a good lateral view of the neck, but both shoulders should be as nearly as possible in contact with the plate. I think it is entirely possible that this same technique can be carried out with the patient lying down upon the table; but in my own laboratory I have found the above position more practical. The tube plate distance is 25 inches. The tube is centered midway between the lower border of the jaw and the upper border of the clavicle and centered directly over the thyroid. I use 8 by 10 duplitized films and double intensifying screens. The exposure will vary from three-fourths to one and a quarter seconds, depending upon the thickness of the patient's neck, with 35 milliamperes, and a 5 inch spark-gap.

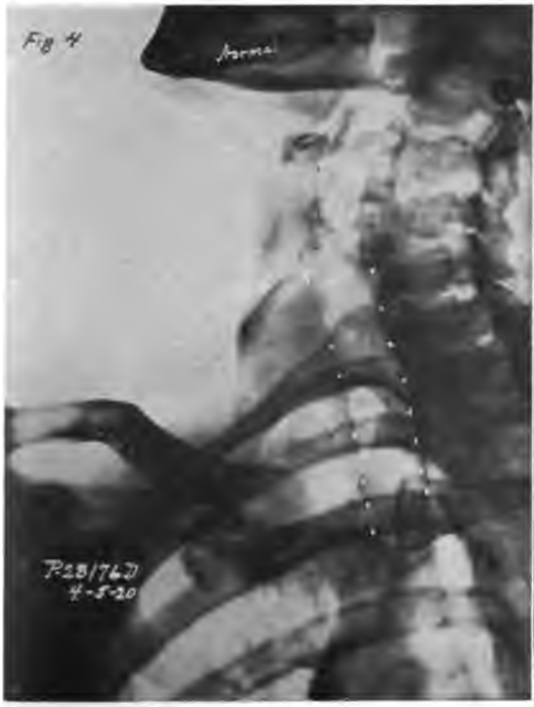

Fig. 4. P.28176-D. Normal Thyroid. Note the Smooth Outline of the Esophagus, and the Size of the Thyroid.

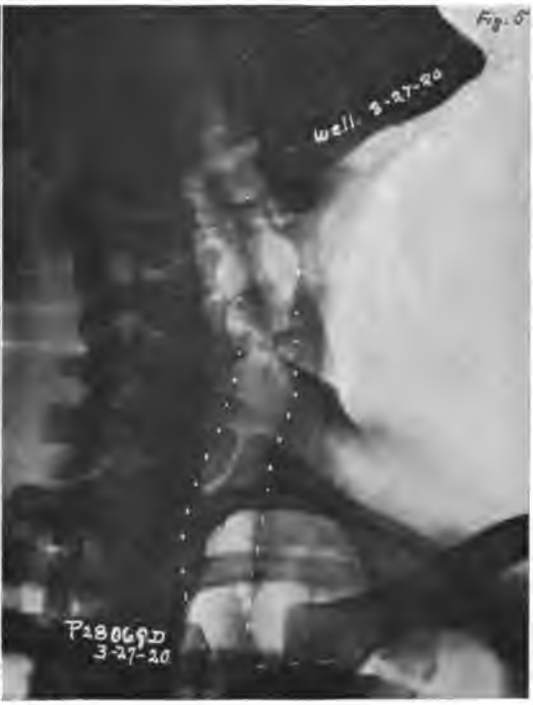

Fig. 5. P.28069-D. Showing Normal Thyroid in a Patient that had been Cured of Exophthalmic Goiter.

With the above technique it is possible and advisable to examine every goiter patient that comes to the office, making a definite record at the beginning of treatment, and making further records during the treatment or at the end of treatment. Further use of this method of examination and detailed study will probably demonstrate more clearly its usefulness.

DISCUSSION

Dr. L. Jaches. I would like to ask Dr. Pfahler to describe the position again. I did not quite get it.

Dr. P. M. Hickey. I was about to ask the same question. I did not quite get the angle. I thought perhaps he would again demonstrate the exact technique.

Dr. B. C. Darling. I would like to ask Dr. Pfahler if there is any possibility of confusing the sternocleidomastoid muscle in that position with the shadow of the thyroid.

Dr. G. E. Pfahler (closing). Answering Dr. Darling's question, if you study those plates carefully, you can see the sternocleidomastoid and why it would not be confused with the shadow of the thyroid. It was shown in a number of the normal cases. If you recognize the normal, it is easy to recognize the abnormal by comparison. I merely present this as a method and not as a final study. (Position again demonstrated by Dr. Pfahler, with Dr. Bowman as subject.)

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ANNUAL MEETING CENTRAL SECTION

The Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY will be held on February 21, 1921, at St. Louis, Missouri.

Communications regarding the program should be addressed to the president, Dr. James G. Van Zwaluwenburg, Ann Arbor, Michigan. The chairman of the local committee, Dr. Edwin C. Ernst, 412 Humbolt Building, St. Louis, may be addressed concerning matters of arrangements.

ANNUAL MEETING WESTERN SECTION

The officers of the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY are making plans for their second annual meeting. They have selected Portland, Oregon, as the place of meeting, and the time has been set for May 27th and 28th. This time will permit of a continuous trip for the western men who desire also to attend the A. M. A. meeting in Boston.

The Pacific Coast Roentgen Ray Society will meet at the same time and place, the two organizations being the guests of the Portland Roentgen Club, a very active organization of specialists.

The Secretary of the Western Section would welcome a visitor or two from the East with papers or demonstrations, and can assure them of a very enjoyable meeting. Address Dr. Warner Watkins, Box 1328, Phoenix, Arizona.

LAWRENCE HERSCHEL HARRIS

Lawrence Herschel Harris died at his home in Sydney on September 13, 1920,

LAWRENCE HERSCHELL HARRIS

after a distressing illness of fifteen weeks due to an encephalitis following influenza. He was the last of Australia's pioneer roentgenologists, having taken up this specialty in the late nineties. He was appointed roentgenologist to Sydney Hospital in 1900, and at the time of his death he was consultant to this hospital and also director of departments of Roentgenology at the Royal Prince Alfred and Royal Alexandra Hospital for Children in Sydney. He was made an Honorary Member of the AMERICAN ROENTGEN RAY SOCIETY in 1916 and was President of the Section of Roentgenology at the Australasian Medical Congress in 1913. He was visiting England in August, 1914, and volunteering immediately left London on August 16th with the Australian Voluntary Hospital for France. Later he was transferred to No. 3 A. G. H. at Lemnos, and after the evacuation of Gallipoli he was invalided to England on account of his dermatitis growing worse.

For many years he had suffered patiently with his hands. This did not affect his uncommonly genial and courteous manner which endeared him to the profession and patients alike.

He was the first man in Australia to do gastro-intestinal work, and as in everything else the standard he set was of the highest. He was always found to be most willing to give others the benefit of his experience. All roentgenologists in Australia owe a very great deal to one whose charming personality and high professional attainment will live long with all, while to the large circle of those more privileged to have known him as a friend, the memory of that kind, generous and true white man will be theirs always.

L. J. CLENDINNEN.

TWENTY-FIFTH ANNIVERSARY OF THE DISCOVERY OF THE X-RAY

The New York Roentgen Society celebrated the twenty-fifth anniversary of the discovery of the *x*-ray on December 11, 1920.

The celebration was held at the New York Athletic Club, New York City, and took the form of a dinner with members of the Philadelphia and New England Roentgen Societies as guests. Fifty-two members and guests were present, with Dr. H. M. Imboden, President of the New York Society, acting as Toastmaster.

Following the dinner Dr. Percy Brown of Boston proposed a silent toast to those former members of the Societies who had lost their lives as martyrs to the advance of roentgenological science.

Prof. J. S. Shearer, speaking on "*X*-Ray and Research," drew attention to the large part that branch has played in the discovery of electrical science and especially of that branch with which roentgenologists are concerned.

Dr. F. H. Baetjer in discussing "*X*-Ray Diagnosis, Its History and Present Status," recounted delightful reminiscences of the early days of the work at Johns Hopkins University in the late 90's and early part of the present century.

Dr. C. W. Holmes followed with some remarks on the present status of *x*-ray therapeutics, and the evening was closed by Dr. W. D. Witherbee, who presented a "Preliminary Report on the Effect of *X*-Ray upon Tonsillar Tissue."

CHARLES EASTMOND.

REPORT OF COMMITTEE ON TEACHING

In recommending a course in roentgenology for undergraduate medical students your committee finds that it is not an easy task to determine just what is the proper amount of instruction to meet the actual needs of the medical or surgical practitioner without loading him with a mass of interesting but technical information that he cannot use.

In determining an ideal course, the question that first arises is whether it is advisable to crowd into a curriculum already more than full, another separate course, when it is so intimately bound up in nearly every other subject of the curriculum that hardly can any branch be properly taught without dealing with its roentgenologic aspects. Does a student then acquire in the other courses a sufficient knowledge of the subject to be able to read and intelligently digest the roentgenologic reports and illustrations in an article or lecture that has a roentgenologic aspect? Your committee finds that there are two extremes with perhaps as cogent reasons for one view as for the other. One of these holds that roentgenology is a specialty for those trained therein and that the medical or surgical specialist be given only the results of his investigations. This same argument would apply with equal force to the pathologist and clinical diagnostician. Who would have the temerity to advocate leaving these two subjects to the mercy of the teachers of other branches?

The other extreme tends to attempt to make roentgenologists of all medical graduates and thus bury completely the subject as a true speciality. There seems to be a middle ground that can safely be adopted, one that will acquaint the student with the scope and usefulness of the agent, enable him to know when to call in the services of the roentgenologist, how to prepare patients for the exination, to understand the reports that are submitted, and to know how and why the conclusions have been reached—all this without any practical knowledge of handling the apparatus or any of the technique employed.

Your committee therefore submits the following as a fair minimum of instruction to accomplish the ends that appear to be desired:

(a) That the subject be taught preferably in the junior and senior years.

(b) That a minimum of forty-two hours be given each student.

(c) That the junior course consist of at least three lectures and demonstrations as a general introduction, and at least twenty-nine lectures and demonstrations dealing with the diagnostic field and therapeutic applications as well as the dangers and methods of preventing injuries.

(d) That the senior course be a minimum of eight hours per student consisting of demonstrations of clinical cases to the sections.

It is especially desirable that the senior students follow their cases to the roentgen ray laboratory, see the examinations made and the findings interpreted and reported.

The committee further recommends that the use of roentgenologic methods be employed to the fullest extent practicable in the teaching of anatomy, physiology and the other fundamental subjects, and that there should be the closest possible cooperation between these departments and the roentgenologist.

A. L. GRAY, *Chairman.*
F. S. BISSELL
P. M. HICKEY
J. S. SHEARER
W. F. MANGES
Committee on Teaching.

REPORT OF SECOND ANNUAL MEETING EASTERN SECTION

The second annual midwinter meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY was held in Atlantic City January 28th and 29th, in the new Chalfonte-Haddon Hall auditorium, with the president, Dr. David R. Bowen, of Philadelphia, presiding.

In point of attendance this was the largest midwinter meeting ever held, and from the enthusiasm expressed by those in attendance, must be rated as one of the most successful.

The Friday evening session was devoted to diversified subjects on x-ray diagnosis. The Saturday morning session was devoted entirely to subjects involving x-ray physics. The Saturday afternoon session was given over to a symposium on x-ray therapy and a symposium on lung diseases. The Saturday evening session, as is customary, was devoted to the lantern slide exhibit. This exhibit has come to be recognized as the place where most roentgenologists bring their difficult and unusual cases.

The discussion at the morning and afternoon sessions on Saturday developed the feeling that there was need for coordinated physical and pathological research in the therapy field. Special emphasis was laid upon the necessity for pathological research, the feeling existing that physical research was advancing beyond the pathological. By resolution the President was authorized to appoint a committee to make recommendations to the parent society at its annual meeting as to how this coordinated research could best be done.

The commercial exhibit was an innovation at midwinter meetings. There was a large number of exhibitors and a great deal of interest centered in the new apparatus exhibited.

At the election of officers, held on Saturday evening, Dr. J. M. Steiner of New York was elected president for the ensuing year and Dr. C. A. Waters of Baltimore, was elected secretary. J. M. STEINER, *Sec.*

A CORRECTION

In the January number of the present volume, page 24, there is an article entitled, "Dislocation of the Carpal Scaphoid." The word "scaphoid" is used throughout the article and in the legend. "Scaphoid" is an error, as the condition is evidently a dislocation of the semilunar bone.

BOOK REVIEWS

A. DAUVILLIER, *Recherches Spectrométrique, sur les Rayons X.* (Thesis presented to the University of Paris.)

This thesis describes the author's experiments on the variation in x-ray spectra when various tubes and methods of excitation are employed. It is indeed fortunate that this admirable piece of research has appeared at this time, when such extravagant claims are made for certain types of apparatus. It is clear that we can never have a rational basis for x-ray therapy until we know the true distribution of the radiation from the tubes. Without definite knowledge of this kind we are quite unable to decide between various operating devices or to coordinate our work.

Omitting, in a brief review, the technical details of the experiments, the points considered and the conclusions are briefly as follows:

1. What variations in spectral emission of x-rays are to be expected with different tubes when operated on various available wave forms?
2. To what degree is the output of short wave lengths influenced by the type of tube and mode of operation?
3. Are the limiting wave lengths observed for different voltages in accord with the predictions of theory?
4. What are the practical indications for therapy?

As regards No. 3 above, the author finds agreement with the theory and determines the displacement of the wave length of maximum ionizing power toward the short wave length portion of the spectrum. He points out that the claims of superpenetration and unusual homogeneity claimed for the Lilienfeld tube are entirely unwarranted from the data at hand, disposing very effectively of the claim that spectral distribution varies with cathode ray concentration.

The practical indications are in entire accord with the views often expressed by those familiar with fundamental physics and who are not misled by experimentation intended to support some preconceived notion or widely advocated method of measurement. The author's statement is as follows:

"The results mentioned permit standardization of x-rays, thanks to the Coolidge tube. We propose to replace the present procedures in dosage, empirical and naturally lacking in precision, by some simple direct measurements of tension, intensity of tube current, distance and the duration of exposure. The fundamentals standardized will be:

"1. The type of tube: Tubes of pure electron emission.

"2. The target material: Tungsten.

"3. The wave form of the electromotive force: Sinusoidal or preferably constant. The independent variables will be:

"4. The maximum tension (measured by a voltmeter).

"5. The mean intensity of current.

"6. The nature and thickness of the filter used.

"7. The distance from focus to skin.

"8. The duration of exposure.

These conditions completely characterize the radiation and permit its exact reproduction independent of all spectroscopic measurements."

The author promises further investigation to determine for all workable conditions the actual spectrum distribution.

With such information as to the delivery of radiation from the tube and the recent exact study of absorption coefficients by Richtmyer and Grant we shall be able to eliminate the vagaries and uncertainties that now beset *x*-ray therapy.

The work of this author and those who supported and encouraged it is not only extremely valuable, but is a splendid example of the true spirit of research. It was carried on as an extra load during the turmoil and strain of the war when so few were even thinking of these unsolved problems.

J. S. SHEARER.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

ROBERTS, PERCY WILLARD, New York City. Syphilitic and Tuberculous Joints. (*Am. J. Syphilis,* April, 1920, iv, No. 2, 302.)

During the past four years he has observed over two hundred bone and joint cases which were undoubtedly of luetic origin and which possessed the symptoms usually ascribed to tuberculosis. It is interesting to note that fifty-one of these cases were diagnosed as tuberculosis by twenty-six experienced surgeons and treated on that basis for periods varying from a few months to fifteen years. In some of them there was a positive Wassermann of from one to four plus, and in all of them there was subsidence of active symptoms a few weeks after the exhibition of mercury and potassium iodide. The Treponema pallidum may produce tubercles identical in structure with those in which the tubercle bacillus is found. In both lues and tuberculosis an affected joint will present symptoms of irritation and there will be muscular spasm. In both diseases there may be enlargement of the joint with effusion and the formation of pus, sterile on ordinary culture media. There may be sensitiveness, limp when a weight-bearing joint is involved and alteration of attitude if the disease is vertebral. *X*-rays may show a bone lesion in either disease, but contrary to accepted theories there are usually no definite characteristics upon which to base a diagnosis. "In a series of fifty of the cases the Wassermann reaction was so frequently negative in the face of other evidence of spyhilis and satisfactory therapeutic results that it may be said that in the late manifestations of inherited lues it is only occasionally of value. The duration of the disease bore no relationship to the possibility of treatment. Two knee cases, one of six and the other of ten years' duration, recovered practically normal function, with regeneration of the necrotic bone area. A spine case of fifteen years' duration gained sixteen pounds in ten weeks. Three out of seven profusely discharging sinuses in this case closed completely and the secretion from the others became thin, watery, and of small volume. When the patient passed from observation, he was able to take long walks and was leading a normal life. A hip case of twenty-five years' standing in which almost constant pain had been a predominant symptom, became entirely comfortable in about ten days. His Wassermann was positive. All of these cases had been under continuous treatment for tuberculosis from the onset of their symptoms."

ROHDENBURG, G. L., AND PRIME, FREDERICK. The Effect of Combined Radiation and Heat on Neoplasms. (*Archives of Surgery,* January, 1921, II, No. 1, 128.)

Low degree of heat applied for varying periods of time have a lethal action on neoplastic cells in vitro, and this lethal action with proper dosage is effective in 100 per cent of cases. Histologic examination of tumors which have been treated by diathermy reveals cellular changes similar to those observed in tumors exposed to radiation.

Wood and Prime have shown that any tumor may be killed by a sufficient dosage of either radium or roentgen ray; but that in maiy instances the patient will not survive the dosage necessary to bring about the death of all the cells of an internal, highly malignant carcinoma or sarcoma. Our experiments demonstrate that by combining radiation with an agent not so destructive to the organism the field of usefulness of radiotherapeutic measures may be extended.

While the principles worked out in the animal experiments here recorded are already being applied in the treatment of cases of neoplasia in human beings, the technical development of the method and the evaluation of the final results will require long and careful observation of the patients before its applicability can be demonstrated.

CHASE, SUMNER B. The Roentgen Ray in the Diagnosis of Sinus Disease. (*J. Iowa State Med. Soc.,* December 15, 1920, x, No. 12, 404.)

Two positions are commonly used, the postero-anterior and the lateral, the latter of which is sometimes stereoscoped. The Caldwell position is commonly used for the frontals. One of the earliest signs of malignancy in the antrum is an even clouding in the plate with a slight break in the outline of the wall. The plate should be carefully examined for signs of teeth such as are found in dentigerous cysts, and if present the alveolar process should be examined for the loss of one or more teeth. These cysts cause bone absorption and not bone destruction. Osteomata present a characteristic appearance of a solid growth, while odontomata show well defined walls enclosing one or more teeth. A giant cell sarcoma presents the usual trabeculated appearance. A malignant growth is differentiated in the plate from the clouding of an empyema or a thickened mucosa by the fact that the bone itself is attacked. The vertical position for the sphenoid examination he regards as important, as by it can be determined the presence or absence of a large posterior ethmoidal cell or a perisphenoidal cell which sometimes lies adjacent to the sphenoid and may simulate disease in this sinus. For instance, the lateral plate will show a cloudy appearance of the sphenoid while the vertical plate will prove this to be a large opaque ethmoid lying adjacent to the sphenoid with the latter clear. It also helps to determine on which side to operate for pituitary tumor by the nasal route because these sinuses are not symmetrical.

A differential diagnosis between polyps and mucocele can not be made definitely although the polyp is more liable to have associated inflammation of the mucous lining of the antrum which would produce a certain amount of clouding of the remaining portion.

He quotes experiments which Caldwell made showing that the shadow cast by various fluids, such as water and pus, was practically the same and that mucous membrane soaked in water casts a much denser shadow than dried mucous membrane.

The roentgen ray is a valuable aid in the diagnosis of accessory nasal sinus conditions Anatomical details of practical surgical and therapeutic importance are shown.

The history, symptoms and clinical findings should be taken into consideration in interpreting the plate.

With properly taken plates, and ruling out previous operative interference, blurring of the margin, or entire extent, of the larger sinuses is interpreted as a pathological condition in the sinuses.

The obliterations of the septa in the small sinuses as the ethmoids, with correctly taken plates and no previous operative interference, indicates pathology present.

The roentgenogram of the sphenoidal sinus as to the condition of the lining of the sinuses is still unsatisfactory.

In certain conditions the diagnosis of the pathology present may be made by the *x*-ray alone.

Pathology is very rarely found in sinuses that appear absolutely normal in the roentgenogram, although it is possible in early acute cases to have pus present with practically no shadow shown in the plate; and all clinical means of examination should be used.

STEINDLER, ARTHUR. Congenital Malformations and Deformities of the Hand. (*J. Orthopedic Surg.*, November, 1920, ii, No. 12, 639.)

This very interesting paper is enhanced by the following classifications:

A. Deformities by developmental suppression, agenesis:
   1. Congenital Defect of the Forearm Bones.
   2. Lobster Claw Hand.
   3. Ectro-dactyly (A-phalangism).
   4. Hemimelia.

B. By Developmental Arrest.
   1. Syndactyly.
   2. Sym-phalangism.

C. By Developmental Aberrations.
   1. Polydactyly (some cases).
   2. Hyper-phalangism.

D. Dysplastic Conditions.
   1. Chondro-dystrophy.
   2. Brachy-dactyly (some cases).
   3. Fusion of carpal bones.

E. Polyglandular Dystrophy.
   1. Polydactyly (some cases).
   2. Macro-dactyly.
   3. Arachno-dactyly (partial gigantism).

F. Contractures (Neurogenetic or amniotic).
   1. Contracted Club Hand.
   2. Contracted Fingers.
   3. Amniotic contractures (non symmetrical).

The author confines himself closely to the discussions of his classifications in the twenty-five case reports which are summarized in the following:

1. Of the 25 cases reported, hereditary tendencies were in evidence in 5 cases, deformities of the hand being found in other members of the family in 3 cases, other deformities or anomalies in 2 instances. Identical deformities in family twice, one case of syndactyly and one case of congenital club hand.

2. Complicating deformities of the extremities were found in 15 cases, among which complicating deformities of the hand 4, namely: Symphalangism in one case of syndactyly; Syndactyly in one case of congenital ulner club hand; Syndactyly in one case of contracted club hand, and syndactyly in one case of lobster claw hand.

3. Complicating deformities of the spine and thorax were found in 3 cases.

Rhachitic deformities of spine and thorax in one case of syndactyly.

Congenital scoliosis with wedge shaped vertebrae in one case of contracted club hand.

Elevation of scapula, wedge formation of vertebrae and fusion of ribs in one case of congenital contractures of the fingers.

4. Complicating signs of degeneration and general developmental aberrations were found in 5 cases.

Acrocephaly in one case of syndactyly.

Malformation of genitals, high palate in 2 cases of contracted club hands.

Cleft palate in one case of aphalangism.

Three cases of this group showed deformities and contractures in all extremities.

5. Birth complications were found in 4 cases.

Instrumental delivery in 3 cases (1 syndactyly, 2 congenital club hands).

Twin birth and cord constriction in one case (contracted club hands and general contracture).

6. Primary developmental errors were assumed to be the causative agent in the majority of cases, in one case only amniotic constrictions could be held responsible; polyglandular (endocrine) dysfunction was suggested in 3 cases by malformation of the bones of the head and genital hypoplasia.

ORMEROD, F. C. On the Treatment of Oriental Sore by *X*-Rays. (*Lancet*, October 30, 1920, p. 893.)

During 1918-19 the author treated a large number of oriental sores by applying *x*-rays and observed satisfactory progress in most and cure in a large percentage of cases.

The advantages of the *x*-ray therapy may be enumerated as follows: 1. The rays act directly on the causative organism. 2. They are able to penetrate unbroken skin or masses of diseased tissue, thereby being efficient in ulcerated and non-ulcerated sores alike. 3. Cases can be treated as out-patients and can very often continue their occupation. 4. There is no risk of constitutional disturbance, the danger of dermatitis or necrosis being absent with the doses utilized. 5. The treatment is short, painless and easy to administer. 6. Doses in awkward positions, such as the inner canthus of the eye, lips and alae nasi can be very readily dealt with.

7. The scars left after healing are supple and of such color after about six months as to be barely noticeable.

In conclusion, the author suggests that *x*-ray therapy may be of value in the treatment of the allied forms of leishmaniasis—espundia and kala-azar—as *x*-rays have an undoubted effect on the Leishman-Donovan body.

HARET AND TRUCHOT. Radiotherapy of Sciatica. New Technique. (*La radiotherapie de la sciatique. Essai de technique nouvelle. Bulletins et Mémoires de la Société de Radiologie médicale de France*, October, 1920, No. 72, p. 122.)

These authors briefly review the work of previous radiotherapists and describe the following as the technique they have used with the best results in eighteen cases. In six cases of sciatic neuralgia (pain symptoms only, without atrophy or change of sensibility and with normal reflexes) they got six cures with two and three series of five sittings each. In twelve cases of sciatic neuritis (continuous pain, muscular atrophy, trophic trouble, troubles of sensibility, abolition or diminution of the tendo achilles reflex) they got seven cures with three and four series of five sittings each; three cases much improved, with the same amount of treatment, and two cases only slightly improved, frankly considered as failures.

The authors refer to the differences of opinion of the massive dose and divided dose enthusiasts. They recommend the use of the Coolidge tube, four milliamperes of current, with twenty-five centimeter (ten inch) spark-gap;

anticathode-skin distance twenty-two centimeters (9 inches). The treatment was administered over the foramina of the fourth and fifth lumbar vertebrae and the first, second, third and fourth sacral vertebrae of the affected side. In one class of patients, they gave doses of three H. units measured under three millimeters of aluminum filter at eight day intervals. A second group of patients received 1 H. unit measured under three millimeters of aluminum every other day with an interval of one week's rest after five or six sittings. To a third group during five consecutive days they administered a daily dose of 1 H. unit measured under four or five millimeters of aluminum filter; then five days of rest. A new series of five sittings was then given with a daily dose of 1 H. unit followed again by five days of rest and so on. The authors have finally settled on this last technique as giving them the greatest degree of success. The different cases varied in their response to treatment, but generally one sees a definite improvement by the end of the second or third sitting. In a few fortunate cases, they have obtained cure with two series of five sittings each; they have never exceeded four series on anybody.

JAMES T. CASE.

DUNCAN, REX. Epithelioma of the Lip, with Observations and Results in the Treatment of Eighty Consecutive Cases with Radium. (*Urol. and Cutan. Rev.*, xxiv, No. 10, 586, October, 1920.)

From a study of eighty consecutive cases, the author reaches the following conclusions: Epithelioma of the lip may occur at any age, near or after the third decade and in the absence of any definite etiological factor. Any wart-like, ulcerated or indurated lesion of the lip which persists more than two months under ordinary treatment, must be considered suspicious of malignancy. In questionable cases a section for diagnosis followed by immediate treatment is advisable. In the majority of cases, the macroscopic appearance is typical and a diagnosis can be made by a competent observer. Epithelioma of the lip is always a serious condition and should receive prompt treatment.

Radium therapy yields a higher percentage of cures than any other method of treatment. There results less inconvenience, loss of function and disfigurement than from surgery or other treatment. Palpable lymphatic glands should be immediately treated with radium. If unimproved after four weeks, they should be resected and radium buried within the wound. A uniform application over the lesion, and in certain cases the burying of the proper dosage within the tumor, are essential. This is obtainable only by the use of radium emanation.

TAFT, A. ROBERT. The Comparative Value of Radium and *X*-Rays in the Treatment of Keloid, Nevi, Angioma, Leukoplakia and Other Lesions of the Skin and Mucous Membrane. (*Urol. & Cutan. Rev.*, Vol. xxiv, No. 10, p. 590, October, 1920.)

The author's results with keloid have convinced him that while the *x*-ray is a splendid remedy and the only one until the introduction of radium, yet the radium is even better.

In leukoplakia the hardest rays possible are advocated by everyone, and this in conjunction with the ease of application makes radium the ideal remedy.

In acne vulgaris the large area to be covered makes *x*-ray the choice, but in acne rosacea the author believes that radium is more efficient.

In lupus vulgaris, lupus erythematosus, ring worm, sycosis, etc., he has used the *x*-rays with such satisfactory results that he has hesitated to make a change.

It has been noted that in some skin diseases covering large areas, psoriasis for example, limited treatment with *x*-ray and clearing up a few lesions will result in a marked improvement of all other lesions. This is said to be due to some general effect. The author has treated in this manner lichen planus, various types of eczema, etc., and has seen many of these clear up generally as a result of a few local treatments. He believes the results to be due to absorption of killed diseased cells with formation of vaccines. It is so much easier to produce a local reaction in definite small areas that radium is better for this purpose than *x*-rays. Three cases of chronic genital sores were treated successfully within the last year by radium.

Angiomata, especially of the lips, responds well to radium, which is certainly the remedy of choice although in larger growths fulguration followed by radiation is quicker and easier.

Nevi are better treated by radium than by any other method. Although warts respond well to radium, a less tedious and less expensive treatment is to be advocated in all but selected cases.

WILKINS, W. A. The Diagnostic Value of the *X*-Ray Examination in Pulmonary Tuberculosis (*Canadian Med. Assn J.*, Vol. x, No. 11, p. 99, November, 1920.)

Since the earliest days of roentgenology the aid of the *x*-ray examination has been invoked for diagnostic assistance in cases of suspected pulmonary tuberculosis and to-day its employment is a very important part of the routine examination of the chest. Nevertheless, there is considerable confusion concerning the interpretation of the shadows seen on the plate. The *x*-ray appearances of pulmonary tuberculosis vary with the stage of the disease. The shadow cast by the pathological tissues may be of any degree of density, including the faint filmy shadow of the very early case, the mottling of the more advanced disease and the dense shadow of the healed lesion. At times, the first indications of disease will be detected by the physical examination; at other times the *x*-ray alone will show the early changes and the *x*-ray affords the most accurate information that can be obtained apart from the autopsy, at least for the extent of the disease. Usually when physical signs are present, the *x*-ray will demonstrate the area of involvement to be more extensive than was indicated by the physical examination. No method or combination of methods at present employed will detect invariably the earliest signs of disease in every case nor decide positively at all times the activity of a lesion. The *x*-ray will demonstrate the site and the extent of the tissue changes, and although usually it is possible to infer from the *x*-ray plate alone whether the lesion is active or not, this decision should be left to the clinician to make. To discover on the *x*-ray plate indications of pathological changes in the tissues, usually requires the support of clinical evidence of disease, before concluding that the changes can be due only to tuberculosis. Otherwise the discovery may consist of nothing more than the recognition of a condition which has long since ceased to be a matter of medical interest. The clinical support need not be confined to the presence of physical signs within the chest, but may be manifested by the presence of general symptoms of ill health. Definite indications of pathological changes in the lungs so often are seen on the *x*-ray plate, not only in individuals who apparently are in perfect health, but also in those who give no history of having suffered from a serious illness at any time, that one is forced to the conclusion that tuberculosis of the lungs is frequently a mild disease, often running its course from onset to recovery unrecognized.

DAVIS, J. S. The Radical Treatment of *X*-Ray Burns. (*Ann. Surg.*, Vol. lxxii, No. 2, p. 224, August, 1920.)

X-Ray burns are usually caused by the use of *x*-rays in the treatment of skin lesions, such as psoriasis, eczema, superficial epithelioma; by frequent exposures extending over a long period of time in the treatment of inoperable or incompletely removed carcinoma; by the reckless use of the apparatus in the hands of unskilled operators and by long fluoroscopic exposures.

The author has had under his care burns situated in almost every region of the body. Some of them have been of the first degree, where the skin is reddened; a few of the second degree, where blisters formed; the vast majority have been of the third degree, where the full thickness of the skin and often the underlying tissues were involved.

Recent *x*-ray burns of all degrees should be treated as ordinary burns but unless there is a fairly prompt response to such treatment it is a mistake to continue it.

Palliative measures should be used in burns of the first degree. Paraffin films are often comforting; painting with collodion, or the application of sterolin (Formula: Balsam of Peru, 4 c.c.; castor oil and Venetian turpentine, of each, 2 c.c.; alcohol, 95 per cent, 100 c.c.), or some bland ointment, are useful.

In burns of the second degree, it is often difficult to tell at first the depth of such a burn, as one which seems to be merely blistered will turn out to be much deeper in places after the blisters have been removed. Wet dressings have been found more comfortable in these cases than paraffin or ointments.

In burns of the third degree which do not heal promptly and permanently by the usual methods more radical methods must be adopted. The ulcer and surrounding area of induration should be excised with a wide margin out to and down to healthy tissue. After excision the defect should be grafted immediately if the base of the wound is of normal tissue, but if doubtful tissue is left, grafting should be deferred until granulations form. The type of graft used should depend upon the situation. The author uses "small deep grafts" in the majority of instances, but has used with satisfaction Ollier-Thiersch, or whole-thickness grafts in selected positions.

Pedunculated flaps from neighboring tissues, or from a distant part, have been of great use in situations where a pad of fat, in addition to whole-thickness, was necessary.

The best method of relieving the pain, aside from the excision of the affected area, is to divide the nerves supplying the area.

X-Ray or radium used in the treatment of *x*-ray burns has not been followed by any benefit. Patches of keratosis on the *x*-ray operator's hand, following frequent exposures without protection, may be successfully treated by freezing with carbon dioxide ice. Should the patches ulcerate, complete excision with immediate or subsequent grafting is the method of choice.

In instances in which tendons have been destroyed it is advisable to fill the defect with a pedunculated flap of skin and fat, and later to restore the tendon by the method best suited to the particular case.

Where large areas are involved we seldom excise sufficient tissue and infection sometimes occurs in the margins of these wounds. There may be sloughing of the entire margin of the wound, although the excision has been apparently complete. For this reason it is wise to defer grafting, or the transference of a flap.

In fulminating infections occurring in areas of the skin which have been burned by *x*-rays, prompt excision with a generous margin is indicated. Amputation of the part may be necessary to control the rapid spread of the infection.

The author's after-results of excision with grafting, or flap-shifting, have been most gratifying. Function has been restored in many instances and patients who have been incapacitated for years have been returned to their former activities.

Denis, W., and Martin, Charles L. A Study of the Relative Toxic Effects Produced by Regional Radiation. (*Am. J. M. Assn.*, Vol. clx, No. 4, p. 555, October, 1920.)

Constant extension of the field of roentgen ray therapy has brought into increasing prominence the condition of "treatment sickness," the constitutional reaction which frequently follows the use of massive doses of the hard roentgen rays. The underlying cause of this reaction is unknown. It has been ascribed to various and diverse factors. A factor which has been considered but little is one involving the question of the relative severity of symptoms following radiation of different parts of the body. The authors have collected the results of experiments with rabbits undertaken to determine whether by the radiation of certain portions of the body roentgen ray intoxication is more easily produced and in more severe form than by radiation of certain other portions.

It was found that a definite dose of roentgen rays administered to the body of a rabbit produces a severe systemic reaction and death only when some portion of the intestinal tract lies within the irradiated area. Furthermore, it is possible to produce a definite acidosis (lowering of the alkaline reserve) in rabbits by administering a heavy dose of roentgen rays over the abdomen. Such animals give no evidence of suffering from a "roentgen ray nephritis."

The results suggest the hypothesis that acidosis may be a factor in "treatment sickness" following abdominal irradiation.

Gunning, R. E. Lee. *X*-Ray Manifestations of Diseases of the Chest. (*Illinois M. J.*, Vol. xxxviii, No. 3, p. 196, September, 1920.)

The early diagnosis of pulmonary tuberculosis presents one of the most difficult clinical problems. The *x*-ray is merely an added form of examination but more exact. This form of examination should never be neglected any more than the stethoscope. It must be remembered, however, that a negative *x*-ray examination does not mean a normal lung. Positive evidence alone is of absolute value.

In all forms of chronic or sub-acute pulmonary tuberculosis with the clinical diagnosis evident, radiology is used simply to (1) confirm diagnosis; (2) differentiate pseudo-tuberculosis; (3) study development; (4) disclose complications; (5) furnish therapeutic indications.

The radioscopic appearance in these cases shows the widest variations as does the pathology. All manifestations from questionable shadows to absolute opacity or involvement of entire hemi-thorax or both pulmonary fields are seen. The most unexpected forms and localizations may be established. The stethoscopic signs may indicate severe involvement and the *x*-ray negate this and vice versa.

Abnormal shadows are seen most often to affect the apices and hilus in general. The shadows are scattered, varying in density and separated from one another by clearer spaces. Tuberculosis develops through foci. In confirmed tuberculosis, abnormal shadows are found on both sides but usually predominating on the side first affected. In advanced cases the shadows reach the lower lobes and the apices become spotted with clear zones due to cavitation.

SOILAND, A. Cancer of the Lip. (*Urol. & Cutan. Rev.*, xxiv, No. 10, 599, October, 1920.)

Every lip case should first of all be given *x*-ray treatment to the entire neck and soft tissues of the lip and jaws, and this should be done most thoroughly. This procedure is now followed in the writer's service, whether or not glands are palpable. The lip lesion itself is then attacked, the method used depending upon the location and extent of the growth. When the lesion is rather superficial and involves not more than one-third of lip along both marginal borders, radium alone is sufficient. If it is a little more extensive and reflected downward over the skin surface, combined radium and *x*-ray give excellent results. If the lesion is more extensive and of cauliflower appearance, electrical desiccation by means of the Oudin bipolar method has given splendid results. After the slough has passed, careful radiation should follow.

Straight surgery of the lip is indicated only where extensive resection is contemplated, and should in all cases be supplemented by radiation.

WEINBERG, JOSEPH A. The Influence of the Exposure of the Roentgen Ray on the Progress of Tuberculosis. (*Arch. Int. Med.*, Vol. 25, p. 565, May, 1920.)

It is generally agreed that the best method for diagnosing tuberculosis of the genito-urinary tract is by the inoculation of the urine of suspected cases into the peritoneal cavity of a guinea-pig. However, this test loses much of its practical value because of the time which must elapse before lesions are apparent in the animal after inoculation. This work was undertaken with two purposes in view: First, to shorten the time of development of tuberculosis; Second, to determine the rôle of lymphocytes as a factor in the protection of guinea-pigs against tuberculous infection.

The author was unable to hasten the progress of the tuberculosis appreciably by exposure of the guinea-pig to massive doses of the roentgen ray.

The leukocytes of the blood stream are markedly reduced in number by exposure to the roentgen ray. The reduction is proportionate to the length of exposure with a given current and voltage. The lymphocytes are most markedly affected.

The cells of the tubercle are probably derived both from the local tissue and the blood. The presence of the usual number of epithelioid and large mononuclear cells in the tuberculous lesions of roentgenized guinea-pigs, where there is a marked diminution of lymphocytes, indicates that these cells are not of lymphocytic origin. The presence of an excess of lymphocytes in and around the blood vessels near the tubercles in non-roentgenized animals indicates that cells are carried to the lesions by the blood stream.

SITTENFIELD, M. J. New Roentgenotherapy in Cancer (*J. Am. M. Assn.*, January 8, 1921.)

The writer reports methods of *x*-ray therapy used in three German clinics visited by him last summer. He states that they are using voltages of 200,000 to 220,000, tubes having been developed to permit this. With this high voltage, short waves are produced in sufficient quantity to permit using heavy filters and still have enough of an almost monochromatic radiation left to be of practical value, and its physical characteristics have been determined sufficiently well to know the amount of radiation in tissues at various depths. He stated that in passing through 10 cm. of soft tissue, only 70 per cent of the total radiation reaching the skin has been absorbed, thus permitting 30 per cent plus scattering to be effective in tissue of that depth. So he estimates that 40 per cent of an erythema dose can be administered to a uterus of the average patient without injury to the skin, and that by using four ports of entry, namely, front, back and two lateral, approximately a full destructive dose can be so given.

Summarizing, he says that the lethal dose for carcinomatous tissue is 90 per cent of the skin erythema dose, that for sarcoma 70 per cent, for ovary 25 per cent. Fibromyomata respond to one treatment, resulting in complete castration.

Carcinomata of the breast is not so situated as to permit of receiving approximately equal amounts of ray in front and behind. Here, though, the tumor is rarely more than 5 cm. from the skin surface; so by increasing the skin-target distance to 70 to 90 cm., 85 per cent to 90 per cent of an erythema dose can be administered to the tumor without injury to the skin, as the effect is in inverse ratio to the square of the focal distance. The time required is 320 to 535 minutes.

The technique as reported for uterine cancer in Bumm's Clinic in Berlin is to ray four areas, one in front, one from behind, and one from each side, using a voltage of 190,000 to 200,000. The skin-target distance is 30 cm., and with a filter of 0.8 mm. of copper for ninety minutes over each area. Blood transfusion follows this treatment.

At Seitz and Wintz's Clinic in Erlangen, six or seven fields are exposed, using 23 cm. distance, 16 inch parallel spark gap, 0.5 mm. of copper or zinc filter for thirty-five minutes each area. This treatment is given in two "sittings" at six weeks' interval.

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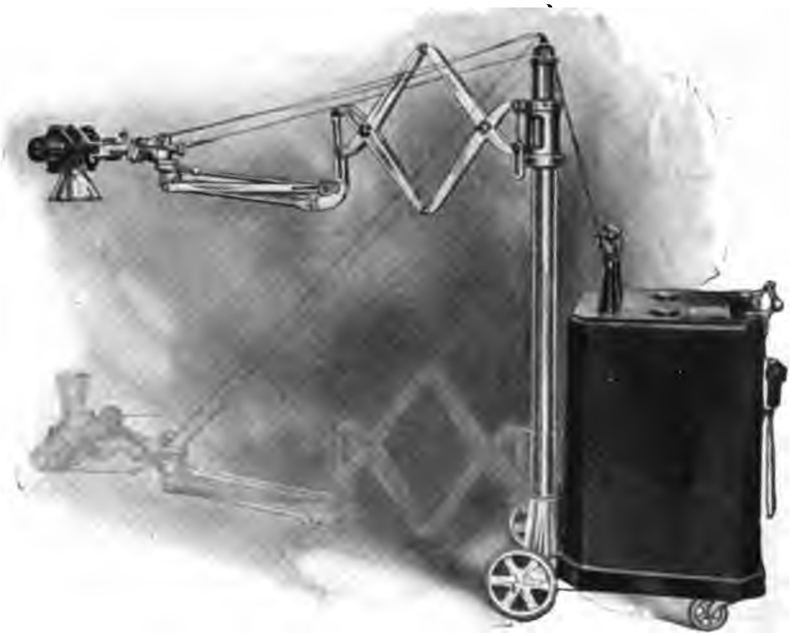

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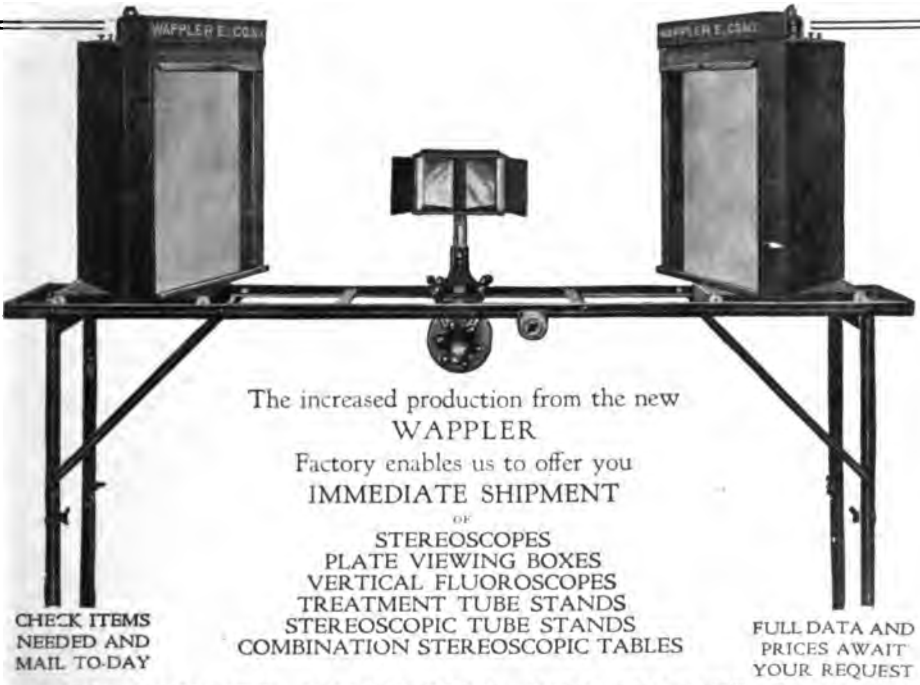

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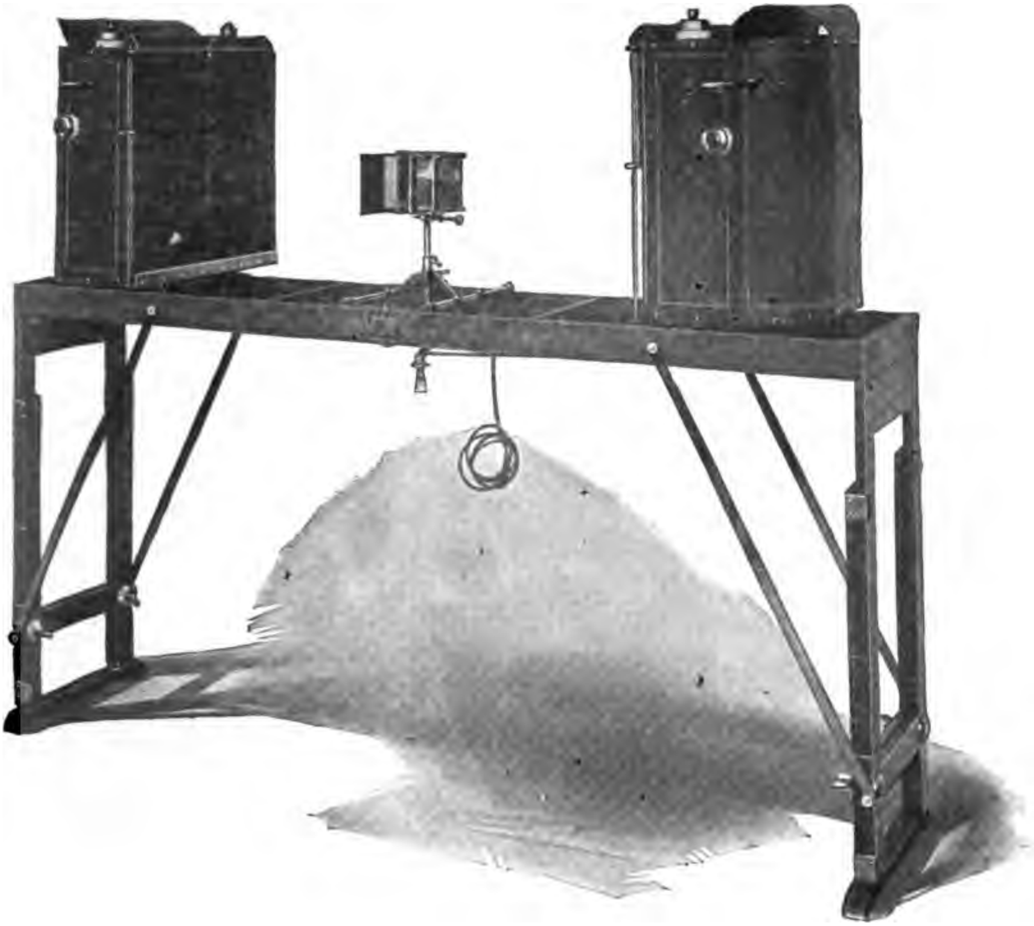

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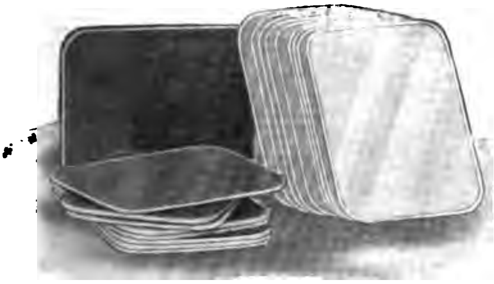

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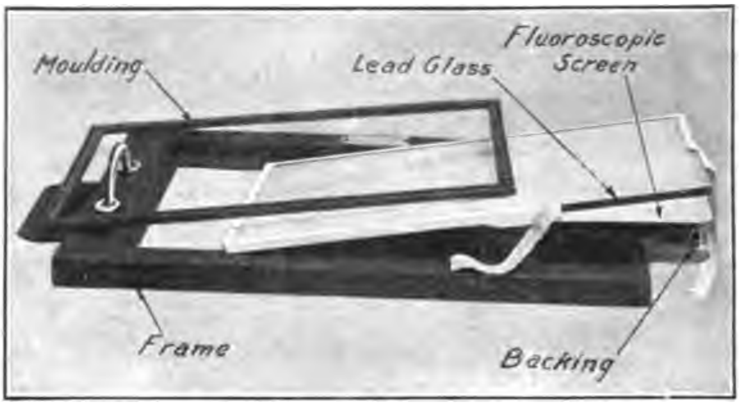

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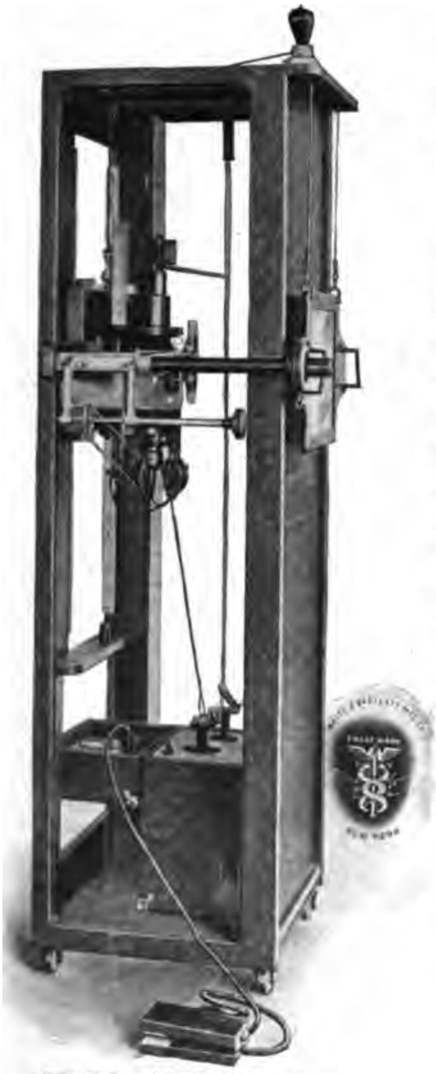

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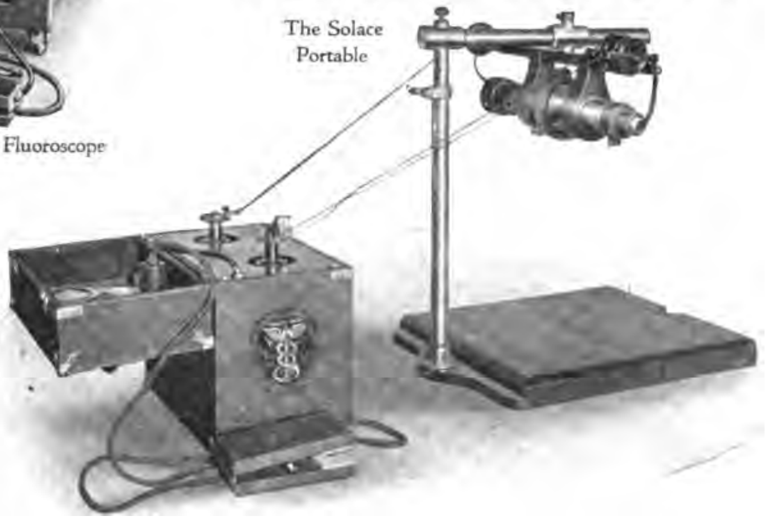

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V. Conditions Necessary for Proper Exposure of the Plate
VI. Development of the Plate

LIST OF PLATES

i, Anatomical Key Plate; ii, Furunculosis in the Auditory Canal; iii, Simple Acute Mastoiditis; iv, Simple Acute Mastoiditis; v, Severe Mastoiditis with Mild Symptoms; vi, Mastoiditis with Bone Absorption; vii, Beginning Abscess Formation; viii, Asymmetrical Mastoids and Thin Cortex; ix, Perisineus Abscess; x, Perisineus Abscess and Sclerosis; xi, Extensive Perisineus Abscess; xii. Large Cholesteatoma; xiii, Cyst of the Mastoid; xiv, Diploetic Type and Chronic Otitis Media with Sclerosis; xv, Undeveloped Mastoids; xvi, Chronic Otitis Media; xvii, Infantile Type, Age 5; xviii, Epidural and Perisineus Abscess; xix, Mastoid Operation with Complete Removal of Cells; xx, Mastoid Operation with Incomplete Removal of Cells; xxi, Large Emissary Vein.

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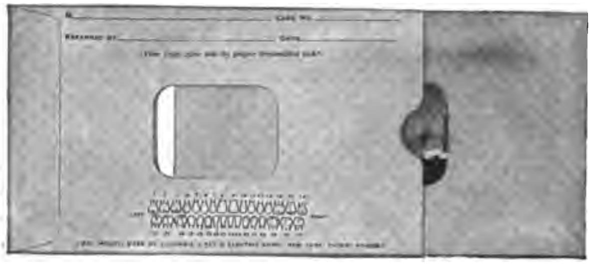

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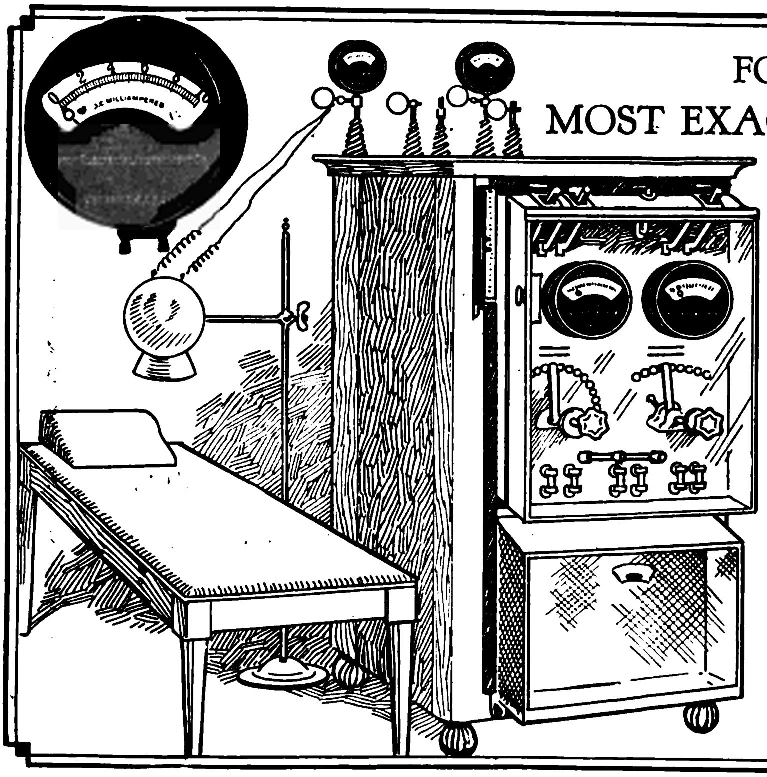

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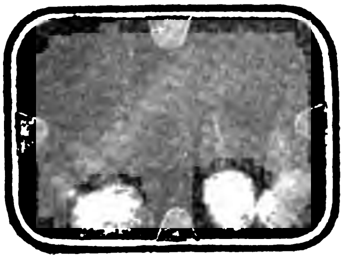

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SYNOPSIS OF CONTENTS

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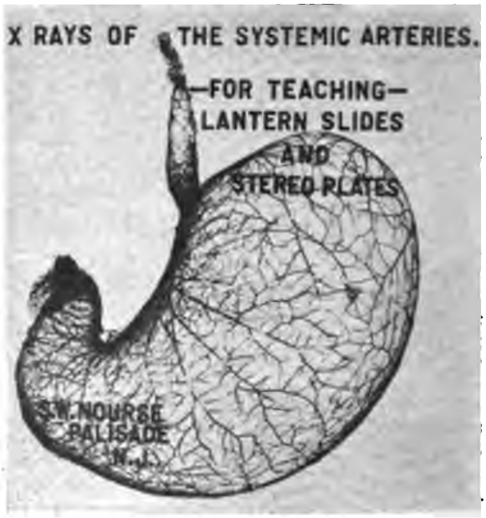

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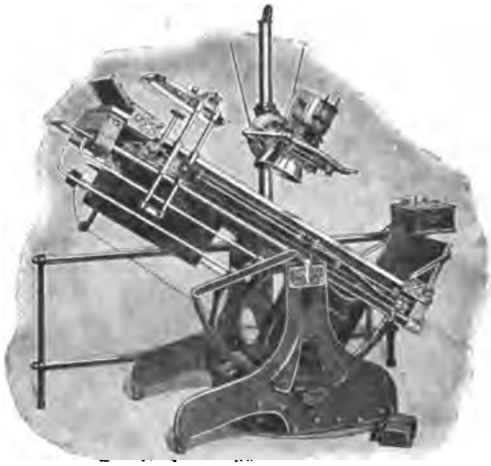

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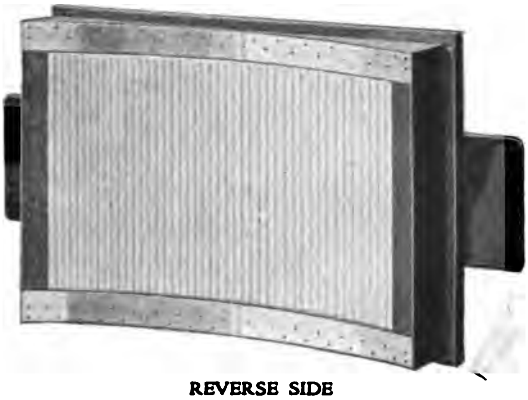

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VOL. VIII (NEW SERIES) MARCH, 1921 No. 3

THE DIAGNOSIS OF PRIMARY TUMORS OF THE LUNG*

By ARTHUR C. CHRISTIE, M.D.

Professor of Roentgenology, George Washington University Medical School,

WASHINGTON, D. C.

A CONSIDERATION of primary tumors of the lungs must deal largely with malignant tumors, since those of benign type are exceedingly rare.

The most comprehensive and accurate description of primary malignancies in the lungs is the monograph of Adler, published in 1912. Adler states that the first accurate knowledge of lung tumors dates from modern times, after Laennec had established the clinical investigation of the chest on a sound basis by application of ausculation and percussion. This he calls the period of the study of lung tumors by clinical methods supported by gross pathology. His latest period, coming down to the time of his monograph, is that in which histology is added to clinical and gross pathological research. Since the publication of Adler's treatise the perfection of the roentgen method of examination of the chest has brought us to another period of much greater accuracy in diagnosis of intrathoracic neoplasms. Indeed, Adler wrote as follows in 1912: "It was not very long ago that A. Frankel wrote that *x*-rays were of little service in the diagnosis of lung tumors. Since then the *x*-rays have become a most remarkable and efficient aid to diagnosis in general, and there exists the well-founded hope of their increasing efficiency as further improvements in apparatus and advances in technique are made. . . . . The hope may reasonably be entertained that with the systematic and proper application of the *x*-rays to the exploration of the chest, the diagnosis of lung tumor may be assured when no other means will give equally certain results."

In 1917 McMahon and Carman, in a communication on "The Roentgenological Diagnosis of Primary Carcinoma of the Lung," described in detail the roentgen appearance of these tumors and gave the essential points in differentiating them from other intrathoracic conditions.

It is the purpose of this paper to state as concisely as possible the diagnostic points by which we are now able to recognize the presence of primary tumors in the lungs and to emphasize certain conditions that have come under the writer's observation from which such tumors must be differentiated.

It is undoubtedly true, as several writers have stated, that there is a certain roentgen picture that is practically pathognomonic of primary carcinoma of the lungs, but there are certain other conditions so closely resembling it that constant watchfulness is necessary to avoid mistakes. It is essential in every case to interpret the roentgenogram in the light of the symptoms, the physical findings, and especially the mode of onset and course of the disease. Unfortunately, like malignant disease in other parts of the body, tumors of the lung may be almost or quite symptomless, but in any case of suspected intrathoracic disease the possibility of lung tumor should always be considered.

---

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

The symptoms and physical signs depend not only upon the size of the tumor but more particularly upon its location.

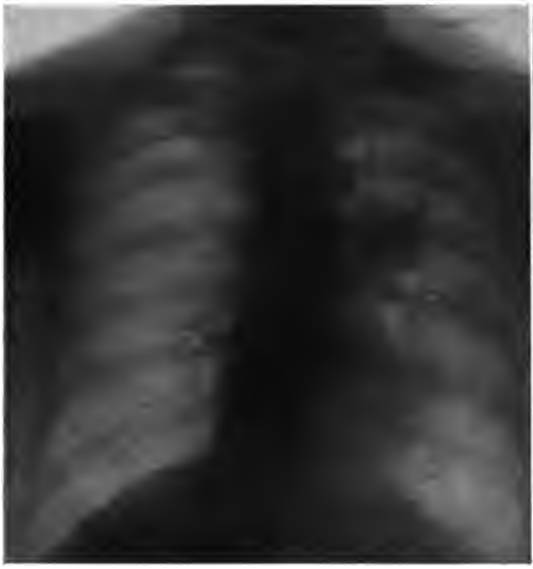

Fig. 1. Primary Carcinoma of the Lung.

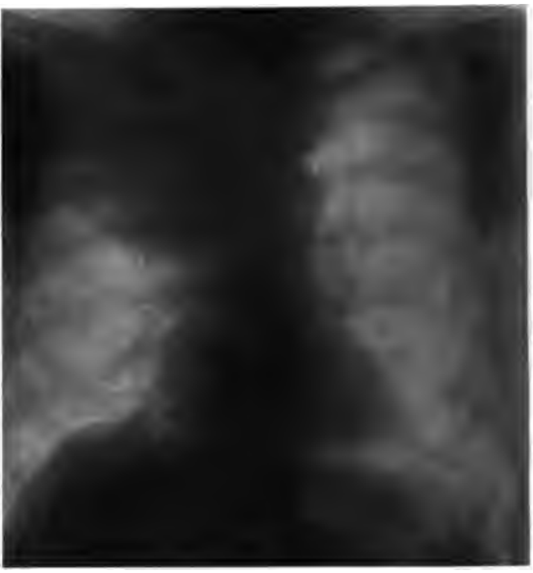

Fig. 2. Benign Tumor—Probably Intrathoracic Goiter.

There are usually no early symptoms that are characteristic, but there may be symptoms to arouse suspicion and lead to thorough investigation. Among the earliest of these may be a slight discomfort—at times amounting to pain—in an area corresponding to the hila of the lungs. There is often, also, a slight, gradually increasing dyspnea. Accompanying the discomfort and dyspnea there may be a dry, unproductive cough.

If these symptoms lead to careful physical examination of the chest, a small area of dullness may be discovered, especially a widening of the area of dullness about the root of the lung. There may also be diminished breath sounds, but no râles. If roentgen examination is made at this time, definite signs of pathology will be seen, depending upon the type of disease. If it is of the infiltrative type, having its origin in one of the large bronchi near the hilus, a roughly circular shadow will be seen extending outward from the hilus. The outer edge of this shadow is not sharply circumscribed but shades off into the surrounding lung shadow and has projecting from it processes that radiate out into the lung. Beyond this shadow which represents the pathological process itself is a more or less extensive area, somewhat less dense than the tumor shadow, and quite homogeneous in character. This is caused by congestion in the surrounding lung and probably also by a partial atelectasis due to some degree of stenosis of the bronchi. If in addition to the above picture there are a few nodules with the same indistinct edges surrounding the central shadow or in relation with the bronchial trunks farther toward the periphery, the picture is quite characteristic of malignant disease of the lung.

The infiltrative type of tumor may also arise from subdivisions of the bronchi or from bronchioles far out in the lung structure. They show the same indistinct edges and projections as those arising at the hila.

In the miliary type of the disease there is diffuse nodulation throughout the lungs, but each nodule or mass of nodules has this same hazy appearance at its periphery, and there is present the surrounding zone due to congestion.

If the appearance described above is present, it may then be stated with a good degree of certainty that the lesion is carcinoma. There are, however, numerous cases of lung carcinoma in which the roentgen appearance is not entirely typical, and there are also conditions which are not carcinoma in which the roentgen appearance closely simulates the latter. It is in such cases that we must rely upon the future course of the disease and corroborative clinical findings in order to establish a diagnosis. The sputum may furnish conclusive or corroborative evidence. In rare cases tumor elements may be found or the fairly characteristic raspberry-jelly or prune-juice sputum may be present. The sputum is often bloody as in other lung diseases. The gradual increase in dyspnea due to growth of the tumor into the bronchi or trachea is a valuable sign. Barker mentions two cases in which he was led to a correct diagnosis by the presence of enlarged lymph-nodes in the neck. The microscopic examination of such a node removed from the neck or axilla may show the character of the process in the lung. The nature of the disease has occasionally been determined by the presence of portions of tumor in a pleural effusion. A hemorrhagic effusion is strongly suggestive of malignant disease.

It is stated that the diagnosis is sometimes established by bronchoscopic examination. Fever is of variable occurrence and is probably due to the presence of inflammatory reaction about the tumor. It may vary from 99° to 102.5°.

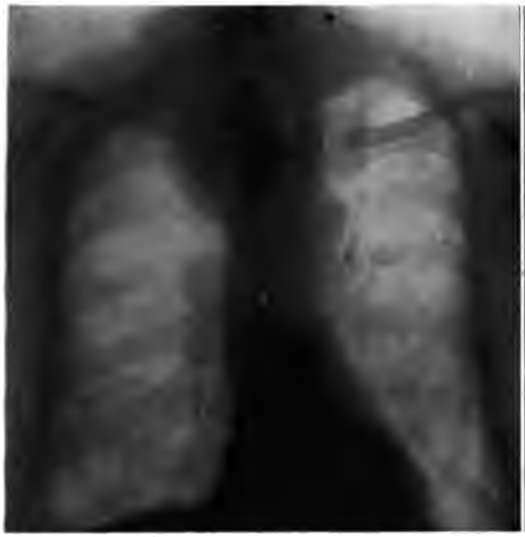

FIG. 3. BENIGN TUMOR, PROBABLY DERMOID CYST.

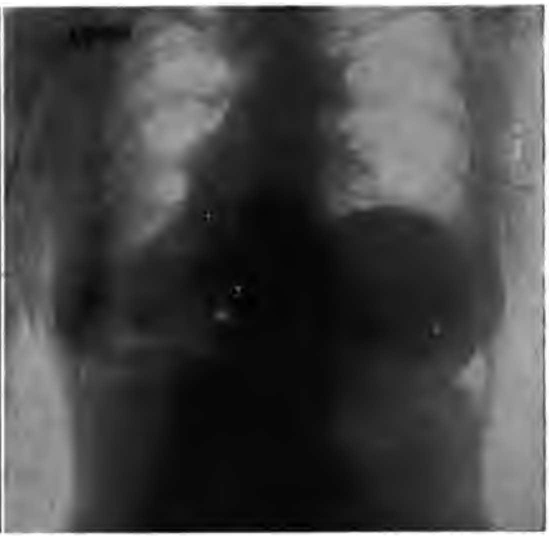

FIG. 4. ECHINOCOCCUS CYST OF LUNG.

Two cases of lung carcinoma which have come under the writer's observation depend for diagnosis upon the manner of onset, the progressive course of the disease, and the roentgen findings, which are quite typical. Both of these cases were men between fifty-five and sixty years of age. The clinical and roentgen aspects of these two cases are strikingly alike. In both cases the first sign of the disease was a sudden attack of fever and cough. The fever disappeared in a few days, but the dry cough persisted. In one of the cases there were several attacks of fever varying from 99° to 102.5°. One came for roentgen examination eight months, and the other six months after the initial attack of fever. In one of them the clinician had discovered a definite area of dullness extending outward from the left hilus—in the other no suspicious physical signs had been found in the chest. In both cases the most prominent symptom was the persistent, irritating cough, but both complained of a feeling of tightness and discomfort in the region of the root of the left lung. Both patients had a slightly cachetic appearance and both had lost a few pounds in weight. Both cases have been given two series of roentgen treatment through many portals of entry with no apparent improvement. One has been under observation about four months, and the other about six months, and in both there has been a gradual increase in the cachetic appearance and a gradual loss of weight. Figure 1 shows the roentgen appearance in one of these two cases.

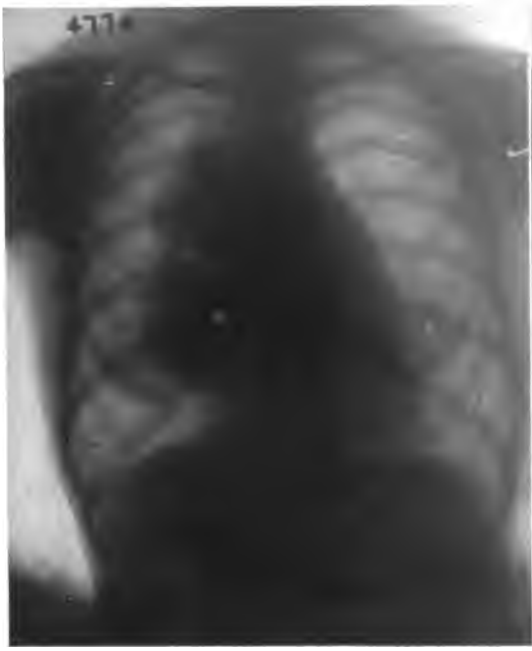

Fig. 5. Mediastinal Tumor.

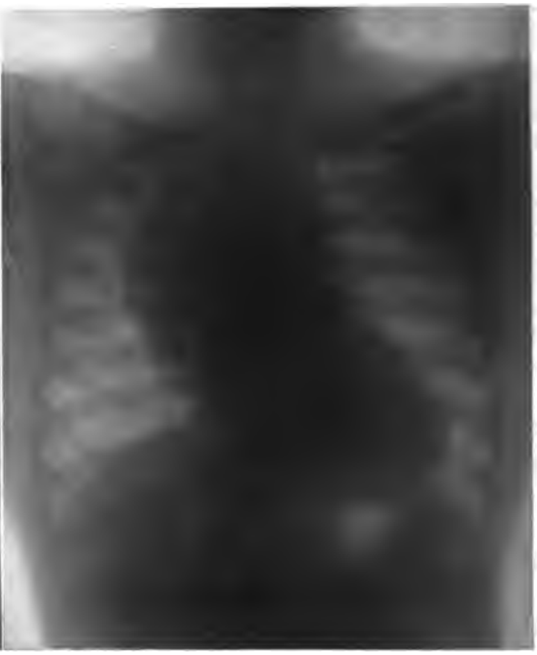

Fig. 6. Mediastinal Tumor.

Benign tumors of the lung occur infrequently but often enough to make it necessary to mention them briefly. It is often possible to make a diagnosis of benign lung tumor when the exact nature of the tumor cannot be stated. For example, Figures 2 and 3 undoubtedly represent benign tumors since they were both observed over a period of more than three years without change in size or contour. Figure 2 is probably an intrathoracic goiter, while Figure 3 is very likely a dermoid cyst.

Echinococcus cyst sometimes occurs in the lung, usually in the lower right lobe. Figure 4 represents a cyst which is believed to be echinococcus, but conclusive evidence such as hooklets in the sputum or positive complement fixation test, was absent. The round or oval, sharply circumscribed contour of benign tumors and their smooth margin makes their roentgen appearance rather typical.

The following intrathoracic conditions may simulate lung tumors more or less closely and must be considered in the differential diagnosis.

Mediastinal tumor can usually be distinguished by the roentgenologic appearance. Oblique examination will show a distinct mass in the mediastinum, and examination in the antero-posterior direction will show the shadow directly continuous with that of the mediastinal structures. (Figs. 5 and 6.)

In mediastinitis there is a general widening of the mediastinal shadow, and those signs and symptoms that accompany an inflammatory process.

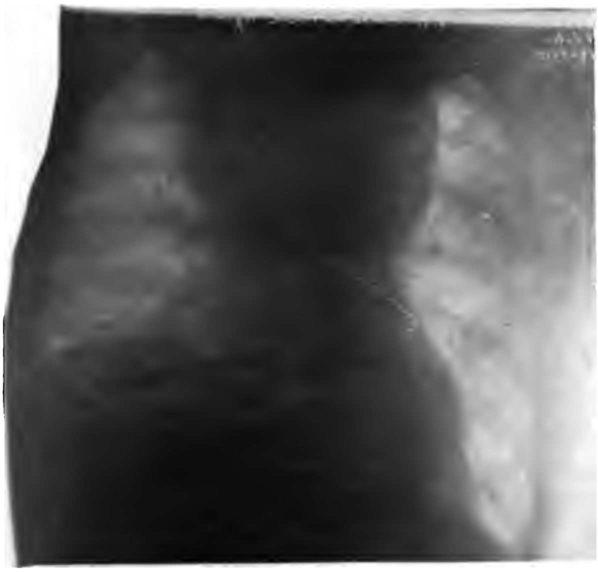

FIG. 7. INTRATHORACIC GOITER.

Intrathoracic goiter and *cystic tumors* of the mediastinum give a rather characteristic roentgen picture. (Fig. 7.)

Gumma of the lung is a condition having much the same roentgen appearance as malignant tumors (Figs. 8 and 9). The diagnosis depends upon the Wassermann test and the disappearance of the mass under anti-syphilitic treatment.

Caseous pneumonia may readily be mistaken for malignancy. The early symptoms may be quite indefinite just as they are in malignant disease, and the roentgen picture may not be distinctive. The irregular temperature, gradually becoming higher as the disease progresses, the presence of râles, the finding of tubercle bacilli in the sputum, and the character of the sputum may serve to differentiate from lung tumors.

There are certain inflammatory processes occurring at or near the hila of the lungs that give much the same roentgen appearance as malignant disease. Such conditions are often seen following influenza, but they may arise quite independently of other disease. We have observed several such cases apparently caused by the streptococcus hemolyticus. These conditions are sometimes a bronchial adenopathy but some of them are undoubtedly localized pneumonic processes. Most of them undergo resolution very slowly and it is at this time, when the patient is afebrile, that a mistake may be made in

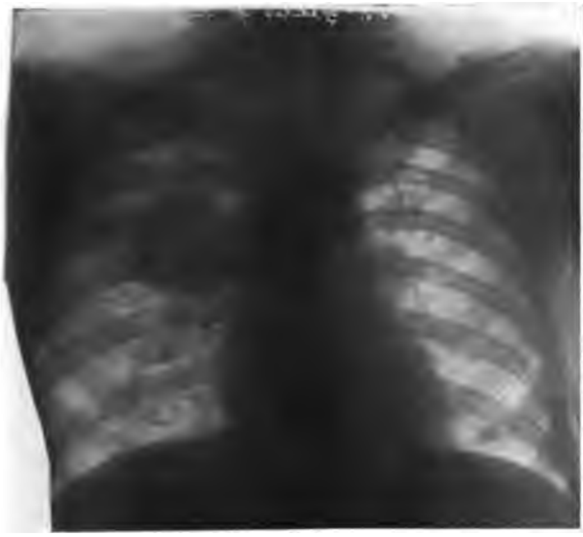

FIG. 8. GUMMA OF LUNG.

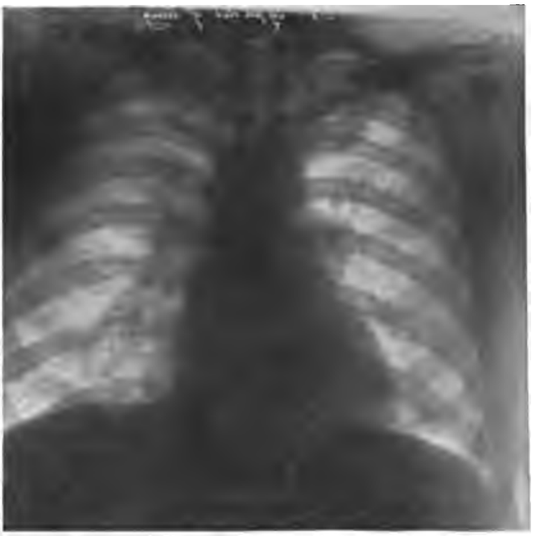

FIG. 9. GUMMA OF LUNG. SAME CASE AS FIG. 8 AFTER TREATMENT.

diagnosing the condition as malignancy of the lung.

There are other conditions, such as bronchiectasis, chronic pulmonary abscess, encysted empyema, pulmonary infarct, and metastatic malignancy, that may be confused with primary malignant tumor of the lung. Careful attention to the history and the roentgenologic findings will in most cases serve to separate them.

It may be stated in conclusion that an accurate diagnosis of lung tumor, with a definite opinion as to its malignant or benign character, can be made in many cases by consideration of the mode of onset, the preliminary symptoms, and the roentgen findings. When, however, the roentgen appearance is not characteristic, the diagnosis must be established by the further course of the disease, and the presence of such signs as enlarged lymph nodes in the neck or axilla, and the character of the sputum and pleural effusions.

It must further be kept in mind that there are certain non-cancerous conditions occurring in the lung which may readily be confused with cancer, especially if only the roentgenologic evidence is relied upon. Among those especially likely to lead to error are gumma of the lung, mediastinitis, caseous pneumonia, and certain inflammatory processes about the hila.

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DISCUSSION

Dr. G. E. Pfahler.—This paper has been so beautifully presented I don't see that there is very much to add. I can only congratulate Dr. Christie on his presentation.

Dr. F. W. Manges.—I too think Dr. Christie's a most interesting and important paper. It has been but a comparatively short time that we have been considering primary carcinoma of the lung, except as a very rare entity, if an entity at all, and I think largely because of the roentgen signs which we found difficult to explain otherwise. In other words, it has been because we have not been able to differentiate our findings clearly that the diagnosis of primary carcinoma has become quite common in the last few years, so that I think this is a most important question now, especially to roentgenologists. Every year our problems of differentiating conditions in the chest are becoming more and more difficult, more and more complex. It must prove to all of us that we made many mistakes in the past, so that I think the paper of Dr. Christie, like that of Dr. Watkins and a number of others on the chest at this meeting, have been most valuable indeed.

I am not going to discuss the paper in the sense that I disagree in any way with Dr. Christie, because I don't. I would like to support practically everything he said.

Dr. George C. Johnston.—I have never seen a case of pleural effusion in primary malignancy. It may be that the cases are not far enough advanced or that they die too soon, or I don't get to see any of them. It is my opinion you get your pleural effusion in secondary carcinoma.

Now, if we take up these cases of primary carcinoma, pretty soon we will have the internist thinking about it when he is examining a man, and you will find they are not at all rare, but are simply overlooked. I have seen a number of cases of primary carcinoma of the lung, and to my surprise, I found they were practically all coming from one man, and he was not the best posted internist I had to work for, either. He was one of the old school of men, and in curiosity I asked him why he was making so many diagnoses of carcinoma of the lung that we could support roentgenologically. He said it was probably because he was thinking about it when he examined the patient. Then I asked him what he based his diagnosis on in some of these cases, and he replied that if you are going to explain afebrile hemoptysis without any pneumonia, it is pretty hard to do.

Dr. A. C. Christie (closing). We often have pleural effusions in primary carcinoma. One of these cases of mine had a pleural effusion, and many reported have had pleural effusions which had to be withdrawn before an accurate picture could be obtained.

I would like to emphasize what Dr. Manges said that the disease is common. It is not such an uncommon disease as we once believed and we must think about it always. Adler reported 374 cases in 1912, and he accepted only those which had been proven by pathologic section. McMahon and Carman reported some 460 cases in 1918. There may have been quite a number since, so there must be a great many more cases than have been reported. Some think it is not very important whether we make an actual diagnosis or not, because the patient is doomed any way, but I think it is a matter of great importance to the patient. Aside from the question of scientific accuracy in diagnosis, it is of great moment to the patient whether he is going to be moved around from here to there as a tuberculosis patient for the rest of his life, with the final destruction of false hopes that he may get well, or whether it is definitely known from the beginning that he has a malignant disease.

THE CLINICAL IMPORTANCE OF THE DIFFERENT TYPES OF PULMONARY TUBERCULOSIS AS DETERMINED BY ROENTGEN EXAMINATION*

By R. G. ALLISON, M.D.
MINNEAPOLIS, MINNESOTA

IN attempting to classify pulmonary tuberculosis into clinical and non-clinical types by means of the *x*-ray, I would like to assure you at the outset that I am fully aware of the difficulties that are to be met with, and am convinced that it cannot be done without a certain percentage of error. I am equally convinced that unless we do attempt this classification we have not done our full duty either by the patient or by the clinician who has referred him to us for an opinion. Entirely too much time has been spent by both roentgenologists and clinicians in advancing absurd claims as to the relative merits of the stethoscope and the *x*-ray in discovering the earliest tuberculous change in the lungs, and entirely too little time spent by either of them in investigating the clinical significance of the lesions when found.

In the past there has been too much hesitancy on the part of the roentgenologist to make, and on the part of the clinician to accept negative diagnoses of pulmonary tuberculosis in the face of toxic symptoms.

Giffin of the Mayo Clinic says: "From the comparison of the two methods we would conclude that pulmonary tuberculosis can be shown as early by the *x*-ray as we can be sure of its presence by other methods, and the negative evidence obtained has in our

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*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14–17, 1920.

experience been of greater value than the positive." Lawrason Brown of Saranac Lake says: "By stereoscopic plates a diagnosis can be made long before physical signs are definite." Rist of the Lannec Hospital of Paris states: "To argue that a pulmonary tuberculosis sufficient to give physical signs would not show definitely on the *x*-ray plate, shows an ignorance not only of the fundamental principles of roentgenology, but of physical diagnosis as well." Thus it would seem that in stereoscopic plates we have the one accurate method of definitely excluding pulmonary tuberculosis.

It is my belief that the greatest factor in making roentgenologists reluctant to make, and clinicians reluctant to accept negative diagnoses of pulmonary tuberculosis, has been the non-recognition or non-acceptance of the fact that there are no symptoms or set of symptoms pathognomic of pulmonary tuberculosis. Until clinicians and roentgenologists accept this fact, the one will be always loathe to make and the other loathe to accept a negative diagnosis in the face of toxic symptoms. Further in this relation I would include in the category of negative diagnosis of pulmonary tuberculosis not only normal lungs, but also lungs showing non-clinical types of tuberculosis.

In my opinion our reports to the referring physician should consist of an objective description of our findings, our impression of these in terms of pathology, and finally our opinion as to whether the lesion is or is not a clinical type of infection. If all our cases were referred by internists and tuberculosis specialists capable of translating objective descriptions of shadows into terms of pathology either obsolete or recent, this might not be necessary; but the majority of cases do not come from them. It has been my experience that by far the greater number of chest cases referred to the roentgenologists come from the general practitioner; and the majority of these are sent for the simple reason that they are presenting symptoms suggestive of an active tuberculosis, with absent or equivocal signs, and the information which the physician desires can be summed up in two questions: (1) Has this patient pulmonary tuberculosis? (2) If so, is it of a type which could account for his symptoms? It is my belief that the first question can be answered correctly in practically every instance. The second can be answered with such a high degree of accuracy, that it should never be neglected, especially as it is the question upon which the whole value of the roentgen method depends. So much has been written on the early diagnosis of pulmonary tuberculosis, and the fact that physical signs may be absent so emphasized, that as Rist aptly expresses it, confronted by a patient, our attitude is not "What ails the patient?" but "Can't we find some tuberculosis to account for his symptoms?" It is in this type of case—and these form at least half of the cases we see—where by making a definite negative diagnosis of a clinical type of tuberculosis, we can start the physician on a further search for the real cause of the patient's symptoms.

Otherwise, if we describe an obsolete tuberculosis as seen on the plates, without an expression as to its clinical significance, the physician will immediately attribute the symptoms to it and the patient be doomed to a sanitarium existence, with all the interference with his future life which that entails. Only a week ago I heard one of our noted sanitarium physicians say: "It is only since I have become convinced of the value of a negative *x*-ray diagnosis of tuberculosis that I found how many different conditions I had been treating as pulmonary tuberculosis."

We as roentgenologists would be far more accurate and valuable if we would confine ourselves to speaking in terms of clinical and non-clinical types of tuberculosis and base our opinions wholly upon the findings of the plates, rather than be biased by the patient's symptoms, and attribute activity to an obsolete infection. Naturally the patient has symptoms or he would not have consulted his physician, and his symptoms are suggestive of pulmonary tuberculosis or he would not have been sent to us. Our duty is to say whether there is a pulmonary tuberculosis present which is capable of producing symptoms, and there our duty ends.

I hope I may be pardoned for having dwelt so long on these simple facts, but for five years I worked in clinical tuberculosis, and during part of that time I received dictated chest reports. During that time the reports were a conglomeration of "increased linear markings," "bronchial interweavings," "tobacco smoke cloudings," and "apical shadows," without any attempt generally to convert these findings into terms of pathology and anatomy and never any attempt to state their clinical significance. Usually I was more in doubt as to what the patient had after reading the reports than before. It is because I can see this from the standpoint of the clinician that I have dwelt so long on the necessity and value of an opinion from the roentgenologists as to the etiology and clinical significance of the objective findings.

From a roentgen standpoint all pulmonary tuberculosis can be grouped under three divisions: (1) The pulmonary miliary process which accompanies a generalized miliary tuberculosis and is hematogenous in origin. Its appearance is characteristic, readily recognized, and seldom confused with other conditions. Its clinical significance need not be touched upon. All pulmonary tuberculosis other than this form can be classified definitely as either (2) parenchymatous or (3) peribronchial, depending upon whether the involvement is in the lymphoid tissue surrounding the bronchus or in the air vesicles themselves. In case both types are present it should be classified as parenchymatous.

The roentgen differentiation of these two types is simple, definite and necessary. It is beyond the scope of this article to delve into the different theories on the mode of infection in pulmonary tuberculosis.

Gohn's classical work on the lungs of children would indicate that all peribronchial tuberculosis is secondary to a parenchymal focus, which may be active or healed, large or small. Regardless of its etiology peribronchial tuberculosis can be definitely differentiated from the parenchymal form by the *x*-ray. The roentgen appearance of parenchymatous tuberculosis from its slightest to its most advanced changes is perfectly familiar to all of us and a description need not be indulged in. The only condition which resembles it closely is an atypical bronchial pneumonia, and here at times we must resort to the time-honored custom of watchful waiting in order to decide with which condition we are dealing. With a history of recent influenza or pneumonia I should wait for a few weeks, for a second set of plates, before pronouncing a slight infiltration or consolidation tuberculous unless there were definite evidence of fibrosis or calcification present.

If the conglomerate tubercles which make up this type of infection are few in number and definitely calcified, and the linear markings extending toward the hilus from them show a cleancut shadow, I do not consider the lesion of clinical significance. Unless it does exhibit this appearance I report it as a clinical type of infection.

Peribronchial tuberculosis, to be considered of clinical importance, should be upper or middle lobe distribution, gross in amount, either unilateral or more marked on one side as compared with the other, and should exhibit a hazy outline and a definite nodular appearance. Unless involvement of the peribronchial tissue conforms to these qualifications it represents either a non-tuberculous infection or is merely the residue of an obsolete tuberculosis.

I have followed the plan just outlined in reporting all chest cases. I have first given the objective findings, then attempted to convert these into terms of pathology. Following this I have then given a positive or negative opinion as to the clinical significance of the lesion.

I have probably missed several cases of active tuberculosis, and I am quite sure that in many of the cases I described as having a clinical type of tuberculosis, the tuberculosis was quiescent and the cases were suffering from other conditions which were producing their symptoms. But on the other hand I am quite sure that in most instances where a negative diagnosis was given, the physician by a further search was able to find some other disease as the cause of the patient's symptoms.

CONCLUSIONS

1. Pulmonary tuberculosis can be divided into clinical and non-clinical types with a high degree of accuracy by stereoscopic plates.
2. Unless we make this division into the two types we are putting our method on the level of tuberculin, which will not differentiate between infection with the tubercle bacillus and the disease tuberculosis.
3. Negative stereoscopic plates can with an occasional rare exception exclude a clinical type of tuberculosis.
4. Parenchymatous tuberculosis is a clinical type unless slight in amount and definitely calcified, and peribronchial tuberculosis is of clinical significance only where it conforms to the following qualifications, upper or middle lobe distribution, unilateral or more marked on one side as compared with the opposite, gross in amount and presenting a hazy outline with definite modulations.
5. A negative diagnosis from the roentgenologist is of more value than a positive, in that in the face of suggestive symptoms, a positive diagnosis can often be made by other methods, but the *x*-ray alone offers the only accurate method of excluding the disease.

THE VALUE OF LATERAL AND OBLIQUE STUDIES OF THE CHEST*

By WILLIAM A. EVANS, M.D.

DETROIT, MICHIGAN

IN reviewing the literature on tuberculosis in children, one wonders at the wide variance of opinion held by men prominent in chest work as to diagnosis and location of lesions. It is agreed that the diagnosis is difficult, and while one writer insists that physical signs are to be depended on first, if not almost entirely, another declares that the ordinary methods of examination are of little value, and that history alone will suffice to determine the diagnosis.

References to the pulmonary area involved are equally conflicting. Fishberg, in an article in the Medical Record in 1917, states that parenchymal lesions are invariably apical, as in adults. This is in direct contradiction to the usual view that parenchymal tuberculosis in children is invariably of the lower lobes. Most of the later workers agree that the roentgen method of examination of the chest is most valuable, some declaring that it is the only method by which a correct diagnosis can be made. Inasmuch as parenchymal tuberculosis is extremely rare in childhood, and peribronchial tuberculosis and a peribronchial lymph node tuberculosis are but secondary developments of a primary root infection, it is evident that the ordinary postero-anterior plates of the chest cannot have a proper diagnostic value for tuberculosis, since the visible changes in this condition to a large extent and for some time occur in the nodes which surround the trachea and the first portion of the bronchi, and these structures are obscured by the heart and large vessel shadows.

We have had the opportunity recently to check physical and radiographic findings, and it has been observed in the cases in which the infection had spread to the outer bronchial, bronchopulmonary and pulmonary nodes, the findings were in harmony, but when the physical findings—and in these cases the d'Espine sign was held diagnostic—were not in accord with the pathology demonstrated by the ordinary plates, lateral

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

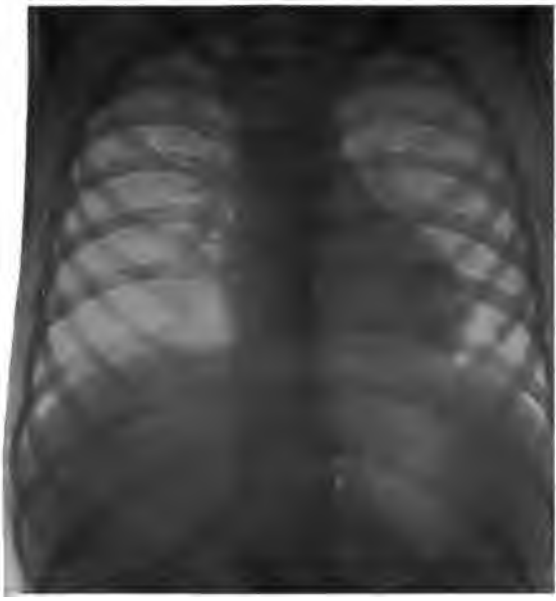

FIG. 1. CASE I. AN ORDINARY POSTERIOR-ANTERIOR PLATE OF A CHILD'S CHEST SHOWING THE ACCENTUATION OF THE HILUM SHADOWS AND INCREASED MARKINGS UPWARDS.

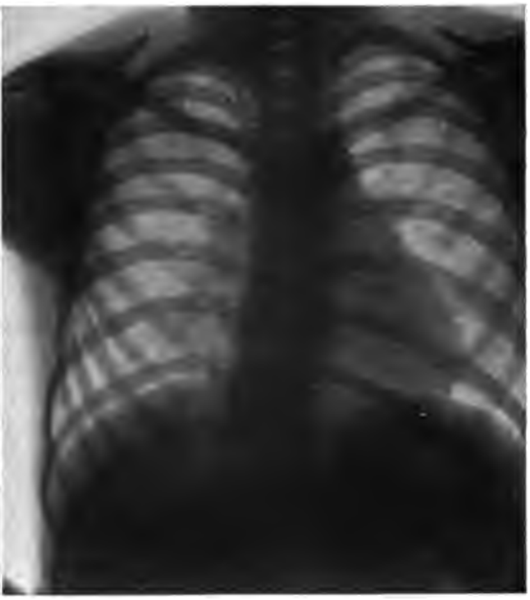

FIG. 3. CASE II. ORDINARY POSTERO-ANTERIOR PLATE OF THE CHEST OF A CHILD. NO ABNORMALITY NOTED.

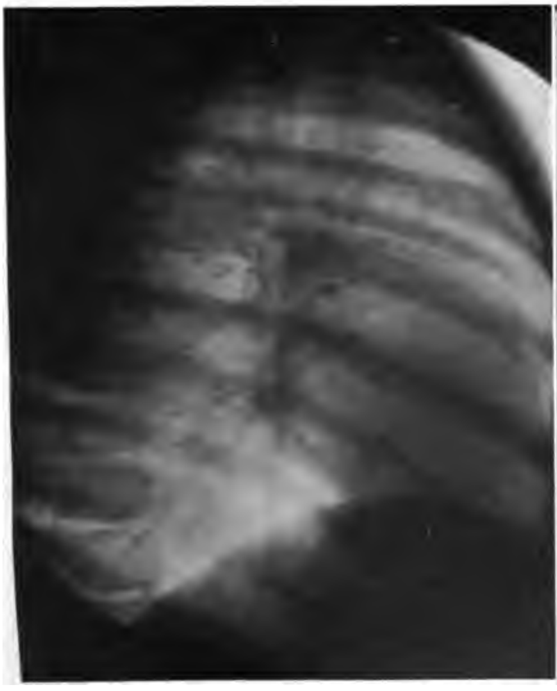

FIG. 2. CASE I. LATERAL PLATE OF THE CHEST SHOWING THE CALCIFIED GLANDS AND MARKED HYPERTROPHY OF THE LYMPHOID TISSUES IN THE SPACE BETWEEN THE HEART AND THE SPINE.

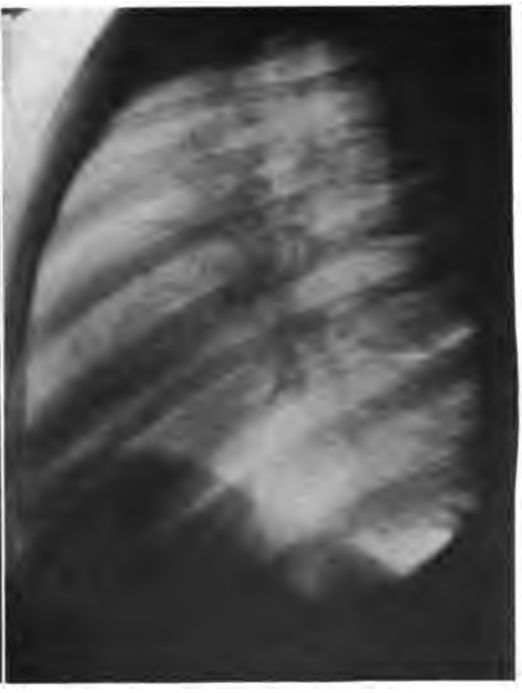

FIG. 4. CASE II. LATERAL PLATE OF THE CHEST SHOWING EXTENSIVE DEPOSIT BETWEEN THE HEART AND SPINE.

plates revealed the enlargement of the tracheal and inner bronchial glands.

We are not to gather from these statements that the diagnosis of tracheobronchial tuberculosis can be made from the radiographic examination alone, for there is nothing characteristic about the enlargement of the glands resulting from infection with the Koch bacillus; but it is important to use a method which will demonstrate the basis for physical signs, and the lateral plate will do this frequently when the standard positions give negative findings.

At this time, I should like to refer to the results of experiments by Krause given in a paper entitled "Experimental Tracheobronchial Node Tuberculosis" published in the *American Review of Tuberculosis,* March, 1919. In these experiments an attenuated strain of Koch bacillus was injected in the groins of guinea pigs. Serial studies demonstrated an early and relatively extensive involvement of all of the lymph nodes in the vicinity of the point of infection. It was supposed for some time that the infection did not spread beyond the abdominal lymph nodes, but later studies showed in all cases involvement of the tracheo-bronchial nodes. Dr. Krause's conclusions from these experiments tend to disprove definitely the Ghon theory that all tuberculosis of the hilus glands is secondary to a pulmonary parenchymal lesion. Dr. Krause suggests that he could agree with Ghon's theory provided the word infection was used rather than lesion, because it is no doubt true that the lymph nodes are, in many cases, infected by inhalation, the organisms being absorbed by the terminal pulmonary lymph vessels.

The value of the lateral study of the chest in adults is particularly great in those cases which present deep-seated abscesses or interlobar collections of fluid. The position of parietal effusions can be easily determined by plates made in both anteroposterior and postero-anterior positions, the size of the shadow, of course, varying on the two sets of plates. The ordinary stereoscopic plates are of no value in these diffuse intrathoracic shadows, because the relation of the density to the anterior or posterior chest walls cannot be determined by this method of study. If the margins of the encapsulated fluid were always spherical or regular, the lateral method would have no special advantage; but frequently the outline of a retained fluid is triangular, so that by the lateral plates the points of approach for thoracentesis or thoracotomy can be advantageously chosen.

The possibility of a successful drainage of a lung abscess by collapse of the lung through artificial pneumothorax can also be determined in advance of the procedure, for in abscesses which are situated near the periphery of the lung, there are frequently adhesions between the pulmonary and parietal pleurae, which prevent lung collapse. This question is especially timely because there are many internists in the country who are electing to treat acute pulmonary conditions by artificial pneumothorax when the pathology present should demand surgical treatment.

The shadow of the right leaf of the diaphragm on the average chest plate is at the level of the eighth or ninth rib posteriorly, the exact level depending on whether the plates were obtained in deep inspiration or in expiration. The lines of reflection of the pleura inferiorly are anteriorly at the level of the eighth costochondral junction, mammary line, the tenth rib in the midaxillary line, and thence to the spinous process of the twelfth thoracic vertebra. The variation between the two sides is unimportant. Therefore any pathology occurring in the posterior phrenocostal space cannot be shown on the standard anteroposterior plates. It is true that plates made in deep inspiration reduce the depth of this hidden field, but at no time is the diaphragm entirely flat. Again, any inflammatory pathology involving the lower lobes causes a fixation and elevation of the diaphragm on the affected side, and the depth of the area under discussion is correspondingly increased.

The lower right lobe is a favorite locality for abscess, probably due to the predilection for foreign bodies to enter the right bronchus.

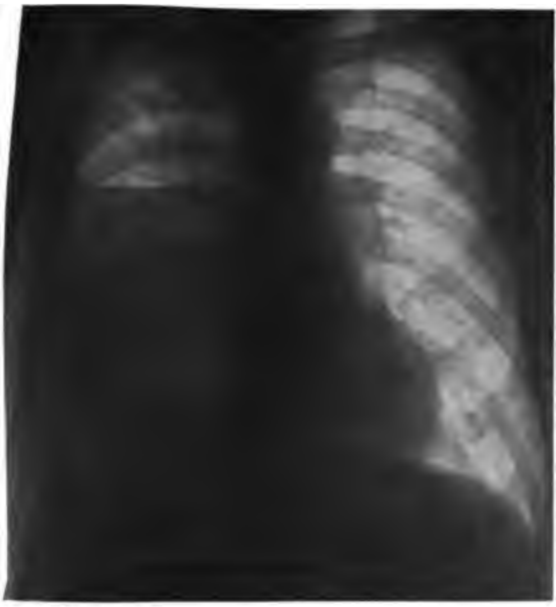

FIG. 5. CASE III. ORDINARY POSTERO-ANTERIOR PLATE OF AN ADULT'S CHEST SHOWING A HYDROPNEUMOTHORAX.

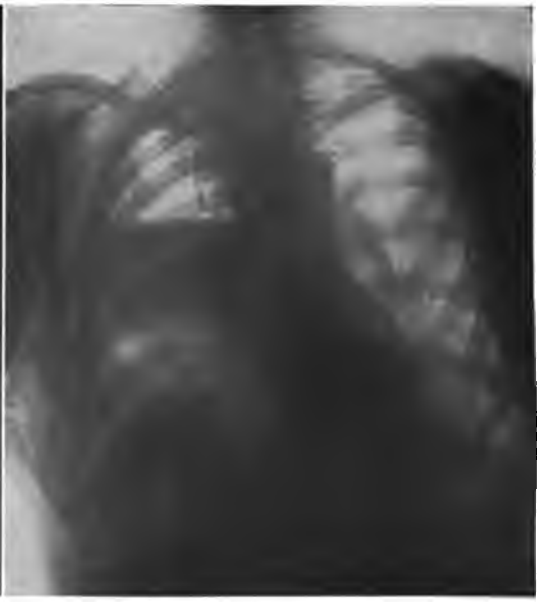

FIG. 7. CASE IV. POSTERO-ANTERIOR PLATE OF THE CHEST SHOWING A HYDROTHORAX.

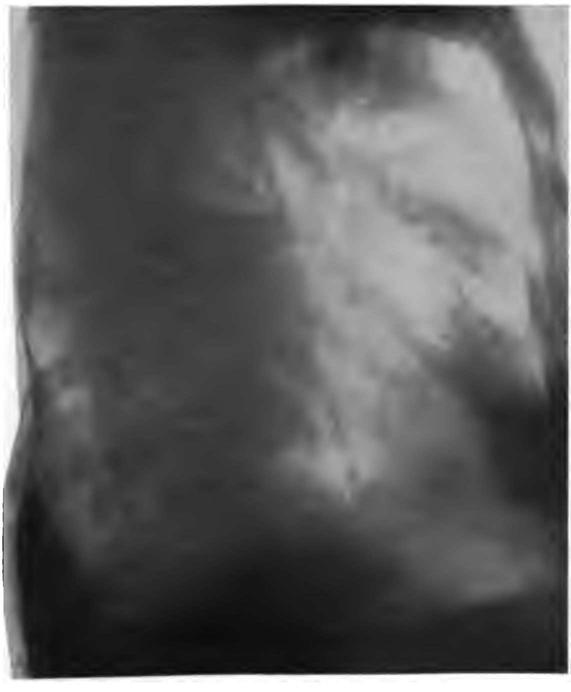

FIG. 6. CASE III. LATERAL PLATE SHOWING THE COLLECTION OF FLUID IN THE POSTERIOR PART OF THE CHEST. NOTE FLUID LEVEL OVERLYING THE SHADOW OF THE SPINE.

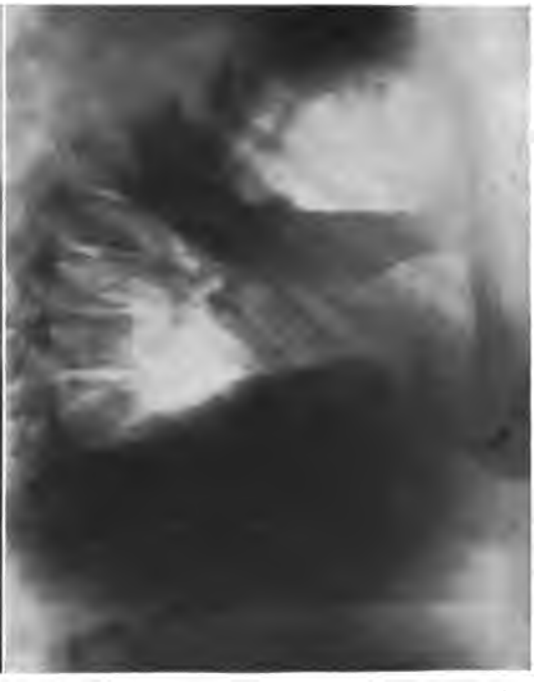

FIG. 8. CASE IV. LATERAL PLATE OF THE CHEST SHOWING THE WIDE DISTRIBUTION OF FLUID FROM THE ANTERIOR TO POSTERIOR CHEST WALL.

Descriptions of three cases recently studied will serve to illustrate the practical value of the lateral and oblique studies of this area.

Case I. Mrs. S, age forty-five. Referred for chest examination with the history of an acute process in the lower right. The findings, at this time, were those of a small amount of fluid in the right lower pleural cavity, there being a loss of the phrenocostal angle. However, the development and severity of the symptoms were out of proportion to the findings, and following withdrawal of the pleural effusion, further studies were undertaken to determine the basis for the persistence of the symptoms. At this time, by the oblique method, we could demonstrate a rounded shadow just below the shadow of the right leaf of the diaphragm, and accordingly a report was made that a lung abscess was present, and that the pleural effusion formerly demonstrated was simply secondary to the deeper lesion. Several days following this examination, in a paroxysm of coughing, the patient brought up a peanut with a quantity of pus, and the case went on from this to complete recovery. At the time of both examinations, no history whatever was obtained that would suggest the presence of a foreign body.

Case II. Mr. C., age twenty-three. The chest plates showed pulmonary pathology involving the lower right lobe, complicated with a small amount of pleural effusion. The patient apparently recovered from this condition, although previous to his discharge from the hospital no radiographic record was obtained of the chest condition. After a lapse of three months, the patient was again referred for examination of the abdomen, with a tentative diagnosis of duodenal perforation or duodenal ulcer. Study of the chest at this time revealed a fixed and elevated right leaf of the diaphragm, with no free fluid in the pleural cavity. The abdominal findings were those of adhesions involving the first and second portions of the duodenum. We described the pathology in the lower lobe, but we did not appreciate its clinical significance, as later events proved.

At operation, adhesions were found in the upper right quadrant, but during the anesthesia, the patient had a severe paroxysm of coughing, and a considerable quantity of pus was expectorated.

We felt that we were at fault in this case, because we did not attach more importance to the pulmonary findings. Due consideration of the oblique findings would have resulted in a very different method of treatment.

Case III. Mr. C., age seventy, with a history of pneumonia which did not clear up within the usual period. Radiographic study of the chest in the standard positions demonstrated a small amount of fluid in the lower right. Again, the symptoms were out of proportion to the findings, and the oblique method of study revealed lower lobe pathology, in addition to the small amount of fluid.

At the time of operation, when the pleural cavity was opened, there was escape of a thin, sanguineous fluid, and not until the lung itself was entered was pus obtained.

A third area in the chest obscured by anatomic structures is the space between the heart and the posterior chest wall. Internists have frequently questioned the interpretation of chest findings in a given case, inquiring as to the possibility of a pulmonary lesion being obscured by the heart shadow. Our experience with Case IV of this series will serve to emphasize the need of having in mind the possibility of collections of fluid which can be obscured by the heart, the heart in the meantime showing no displacement.

Case IV. Mr. H., age twenty-six, post-influenzal pathology. The anteroposterior plate showed slight impairment of density over the lower left lung field, with a visible left leaf of the diaphragm and no displacement of the mediastinal shadows. In spite of our negative report for the presence of any quantity of fluid in the left pleural cavity, a thoracotomy was performed and a pint or more of pus was evacuated. In this case, also, we believe that thorough lateral and oblique studies would have revealed this collection of fluid.

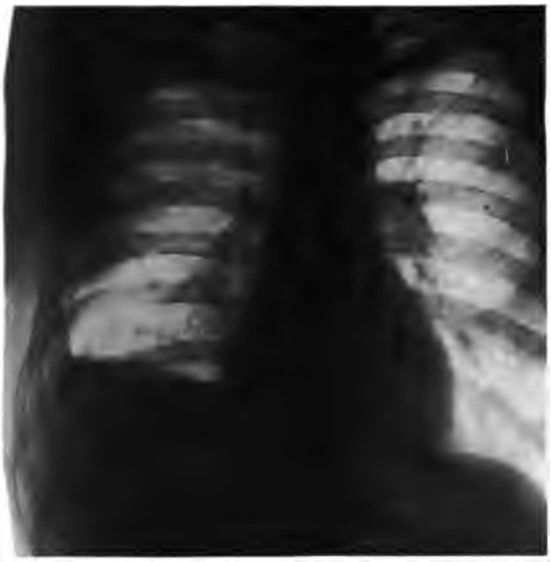

Fig. 9. Case v. Postero-anterior Plate of an Adult's Chest Showing Elevation and Distortion of the Right Leaf of the Diaphragm.

CONCLUSIONS

I am well aware that the above procedure in the examination of the chest is carried on by many workers. My object in presenting it at this time is to emphasize the necessity for a more frequent variation from the standard positions.

The mere reporting of a small amount of fluid in the lower pleural cavity is of no practical value in many chest conditions, for the presence of the fluid is merely incidental to the basic pathology, which is pulmonary.

As regards juvenile tuberculosis, the wide divergence of opinion regarding the mode of infection and the distribution of lesions indicates the necessity for immediate and wide promulgation of the views held by roentgenologists who are familiar with the type and location of visible lesions of tuberculosis.

DISCUSSION

Dr. Kennon Dunham. I wish to thank Dr. Evans for bringing to our attention again the necessity for as complete an examination of the chest by the *x*-ray as is possible. I am sure that he does not mean that we should give up the ordinary stereoscopic postero-anterior exposures from which we gain so much, but he does mean, or at least I think he means, that that is not always sufficient, and it is of utmost importance that every aid should be given to determining these lung tumors. For years *x*-ray men have been working in the lung field, and have had almost no encouragement from the medical profession. The war changed that. They are coming to you and to me to help them solve their chest problems. Just as in Dr. Stewart's work, the bronchoscopist is absolutely dependent on the *x*-ray examination. Now, when we have made an examination, don't let us stop because we are in a hurry. Don't let us get

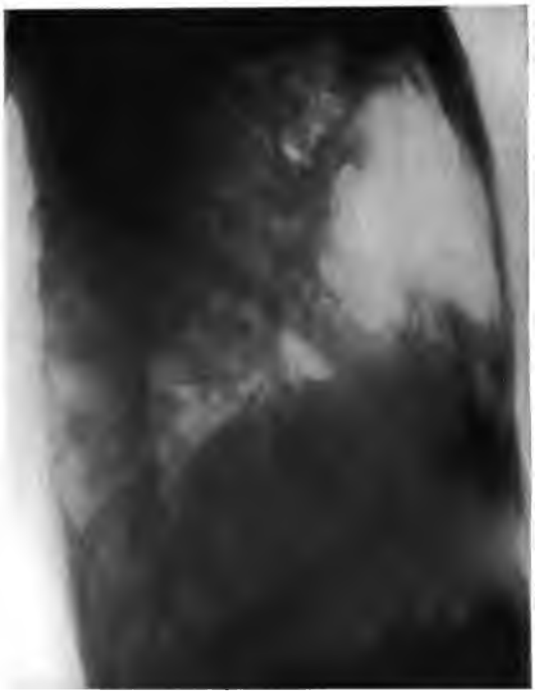

Fig. 10. Case v. Lateral Plate of the Chest Shows Adhesions Involving the Diaphragm well Interior. The Posterior Surface is Clear.

This plate shows graphically the extent of the pulmonary area which is obscured by the ordinary postero-anterior plate.

into a hurry which may cause us to lose an important phase of an examination.

Before I sit down, I simply wish to impress on you that wherever it is possible, please impress upon your clinician that the aid of the *x*-ray is not only necessary in cases they think are important; the great importance of the *x*-ray examination of the chest is where they do not have sufficient physical signs to explain the case. The greatest benefit we have received from the *x*-ray examination has been where it has been done routinely. Every case coming to a hospital should be examined, and that is where you get your beautiful results and most illuminating work. It helps the clinician and then, for the first time in the clinician's life, he wakens up to the fact that his physical examination has its limitations just as the *x*-ray examination has its limitations.

But this method of Dr. Evans' impresses on us the value of the lateral and oblique exposures of the root of the lung, and possesses inestimable value. The stereoscopic plate becomes helpless in front of an absolute density. We cannot stereoscope heavy densities—we do not stereoscope the heart, but they must be studied, and to do this we must find a way. Dr. Evans has shown the way.

A SIMPLE AND PRACTICAL METHOD FOR THE RAPID HARDENING OF GAS TUBES

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AT the present time there are three recognized methods of hardening gas tubes which have become too soft for use:

1. Tubes may be hardened by setting them aside and allowing them to rest for an indefinite period.
2. Tubes may be hardened by passing a weak current through them for several minutes, either through the true or through the accessory anode. The current must pass through the tube until the tube is hot.
3. Tubes may be hardened by being repumped at the factory. The first two methods are time-consuming and unreliable, failing completely in the case of very soft tubes. The third method is time-consuming, inconvenient and expensive.

The possibility of hardening *x*-ray tubes rapidly and conveniently by cooling the softening device with an ethyl-chloride spray or other means suggested itself on theoretical grounds. The efficacy of the method has been demonstrated by the successful hardening of twenty-five different gas tubes. Up to the time of publication fifty tubes have been succesfully hardened. After a short discussion of theoretical considerations we shall give in detail our practical methods and results.

THEORETICAL CONSIDERATIONS

The fact that gas tubes become harder on standing suggests the occurrence of condensation and absorption or adsorption of gas by the tube wall, anode or softening device, and particularly the condensation and absorption of water vapor. The experimental work which resulted in the production of high-vacuum Coolidge tubes taught us that the ordinary low-vacuum tube contains a considerable amount of water vapor. The construction of the ordinary softening device, which consists of some hygroscopic material, such as asbestos packing so placed that it can be heated by the electric current, leads us to believe that the softening of the tube consists generally in the liberation of water vapor and that the hardening which takes place on standing is mainly due to the resorption of the water vapor previously liberated. While the condition of the tube wall and that of the anode and cathode are undoubtedly factors in the state of hardness of the tube, it is probable that most of the resorption takes place in the softening device which, because of its relatively large surface and hygroscopic character, is best adapted for this function.

The avidity with which finely divided substances, such as animal charcoal, absorb gases when cooled to a very low temperature, as by liquid air, suggests the possibility of hastening the resorption of gas or water vapor in a gas tube by cooling the softening device. The rapid fall in vapor tension of water with fall of temperature suggests that the use of even a mild cooling device, such as the ethyl-chloride spray, will be fairly efficacious in causing condensation or increased concentration of water vapor in the cool part of the tube and hence increased resorption and consequently increased exhaustion or hardness. These theoretical considerations are borne out by the practical results which follow.

PRACTICAL METHOD AND RESULTS

The actual method of hardening the tube is as follows:

1. Current is passed through the tube until it becomes fairly hot.

2. The softening device of the *x*-ray tube is sprayed slowly with ethyl-chloride. From thirty to fifty grams is generally sufficient, and during the spraying a coating of snow and ice should collect on the glass bulb of the softening device. It is advisable to protect the bulb of the tube with a towel, exposing only the chamber containing the softening device. A thin layer of absorbent cotton held down by two or three rubber bands placed around the tube wall containing the softening device facilitates the spraying of ethyl chloride. By this method none of the ethyl chloride is wasted or lost and the formation of snow and ice is hastened.

3. Allow the tube to stand five minutes. Dry the tube thoroughly. An electric fan aids in cooling the softening device during the spraying, and also later in drying the chamber containing the softening device.

4. Reheat the tube by passing the current through the anticathode or accessory anode. After this procedure it is generally found that the tube is harder than before and becomes progressively harder for about twenty-four to forty-eight hours. Different tubes vary in the ease with which they are hardened; some require only one treatment and others several repetitions of the treatment. Once the spark-gap has begun to increase it is easy to increase the hardness of the tube to any desired degree by repetition of the above treatment.

On the following page will be found a table containing a list of twenty-five tubes rehardened by this method.

SUMMARY

As a result of our experiments with twenty-five gas tubes of several different types, we wish to emphasize several points which will be useful to any one employing this procedure. It makes very little difference whether the asbestos packing in the softening device is in direct contact with the outer glass wall or is contained in a separate tube. In general older and more highly seasoned tubes require more preliminary heating and respond to treatment more slowly than do newer tubes. The reason for this is that the tube must be heated sufficiently to drive particles of gas from the metal parts and glass wall into the bulb so as to allow this gas to be absorbed by the softening material. Several treatments may be necessary, but once the spark gap has begun to increase it is a simple matter to attain any degree of desired hardness. Frequently it will be found that tubes will show almost no change immediately after treatment but become much harder from one to twenty-four hours after. If at the end of twelve to twenty-four hours the tube does not tend to become harder, another treatment is indicated. Tubes hardened by this method will keep their vacuum and gap indefinitely, as shown by their daily use in the *x*-ray laboratory of Mount Sinai Hospital, New York City. The tendency of these tubes upon standing is to become progressively harder.

We have not had experience with tubes containing metallic regulators as softening devices, therefore cannot state whether this method is applicable to such tubes. Our experience has been limited to tubes containing hygroscopic material.

CONCLUSION

In conclusion, we feel that both theoretical considerations and practical results justify us in stating that *gas tubes containing some hygroscopic material such as asbestos packing can be hardened rapidly and conveniently by cooling the softening device by an ethylchloride spray.*

TABLE I

TUBE	SPARK GAP BEFORE HARDENING	SPARK GAP ONE HOUR AFTER HARDENING	SPARK GAP 24 HOURS AFTER HARDENING	SPARK GAP 48 HOURS AFTER HARDENING	REMARKS
1	Less than 2 in.	3 inches	5 inches	7 inches	Soft since 1916
2	Less than 2 in.	No change	4 inches	7½ inches	Soft since 1916
3	Less than 2 in.	No change	6 inches	6 inches	Soft since 1916
4	Less than 2 in.	3 inches	6 inches	6½ inches	
5	2 inches	5 inches	7 inches	7 inches	Helium
6	Less than 2 in.	4 inches	7 inches	8 inches	Accidentally Softened. Returned quickly
7	2 inches	3 inches	4 inches	5 inches	Helium
8	Less than 2 in.	No change	2¾ inches*	5 inches	
9	2 inches	No change	4½ inches	4½ inches	
10	Less than 2 in.	3 inches	3½ inches	5 inches	
11	Less than 2 in.	4 inches	5½ inches	5½ inches	
12	2½ inches	3½ inches	5 inches*	7½ inches	Old target. Focal spot cracked.
13	Less than 2 in.	2 inches*	6 inches	6 inches	
14	Less than 2 in.	2¾ inches	5 inches	6 inches	
15	2¼ inches	No change*	4 inches	5½ inches	
16	2¾ inches	4 inches	7 inches	7 inches	
17	4 inches	5 inches	5½ inches	5½ inches	
18	5 inches	5½ inches	6½ inches	6½ inches	
19	Less than 2 in.	2 inches	4½ inches	5 inches	
20	Less than 2 in.	6 inches	6½ inches	6½ inches	
21	Less than 2 in.	No change*	2 inches*	4 inches	
22	2 inches	No change*	3½ inches*	7 inches	
23	4½ inches	5½ inches	6½ inches	7½ inches	
24	Less than 2 in.	No change*	No change*	4½ inches	
25	2¾ inches	2¾ inches	3½ inches	6 inches	

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*Denotes re-spraying after testing tube.

REMARKS ON THE TECHNIQUE OF THE ROENTGEN EXAMINATION OF THE KIDNEYS

By W. S. LAWRENCE, M.D.

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MEMPHIS, TENNESSEE

THE technique which I am about to set forth in more or less laborious detail is by no means all my own, if indeed I can lay claim to any of it. It is mostly patched together from the oft-repeated suggestions of others. The only justification for the use of the little word "my" which frequently sets the rest of us on edge, is a certain grouping of the essential and indispensable factors of success, an exacting and persistent carrying out of every detail, together with full knowledge of, and an abiding faith in, the results that can be achieved when this work is done in the right way.

In doing kidney work our chief aim should be to produce plates showing the whole kidney outline clearly, unmistakably and without the aid of the imagination. Such a plate will possess the maximum of diagnostic value in every condition for which we are called upon to examine the kidneys. If the kidney substance shows clearly, denser substances will show much more clearly.

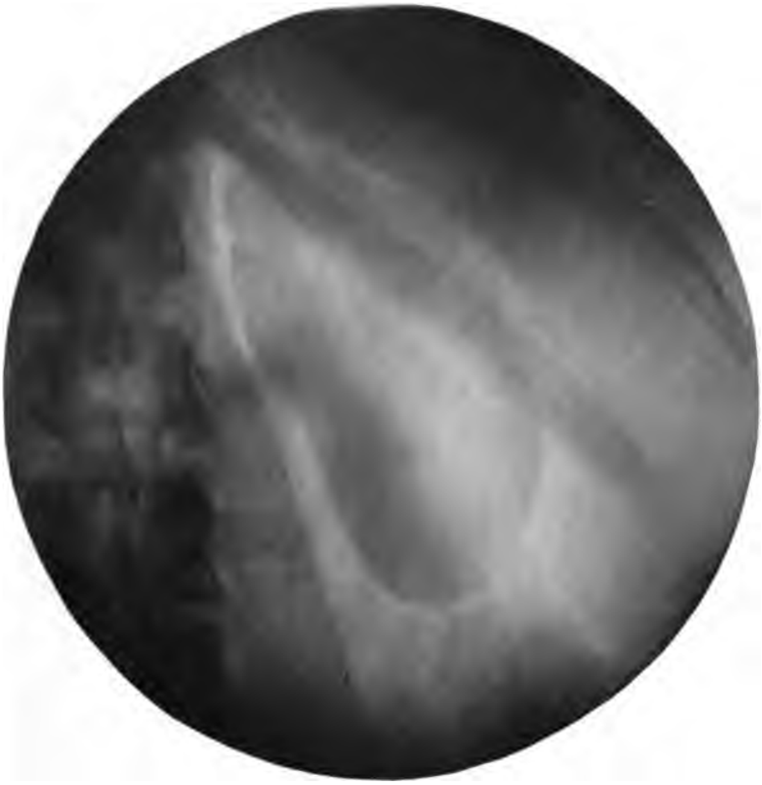

FIG. I. NORMAL KIDNEY—RIGHT. NOTE CALICES UNINJECTED.

To make such plates with uniformity and

certainty there are certain points of technique which are absolutely essential. I will mention them somewhat in the order of their importance, though after the first, there is little choice as to which should be placed second, third or fourth in order of importance. Easily of first importance is the quality of the ray used; second, correct and adequate compression; third, preparation of the patient; fourth, control, real control, of the patient's respiration.

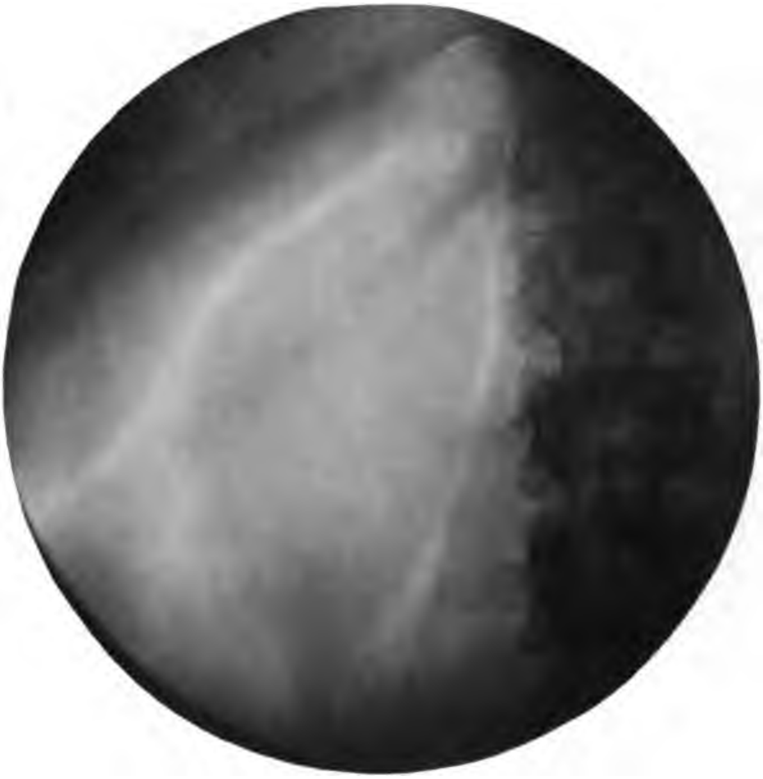

FIG. 2. NORMAL KIDNEY OUTLINE—LEFT KIDNEY.

Kidney plates should be clear, soft and sharp, suggesting under-exposure rather than over-exposure. No black should anywhere appear on the plate. Such a plate cannot be made if the tube is excited by a current of high voltage. In actual practice I use a 3 to 3½ inch spark gap, 35 milliamperes, and an exposure varying from four to eight seconds depending upon the size of the patient. The time only is varied.

Second in importance and very much more difficult to obtain are proper compression of the patient and correct placing of the compression cylinder. For accuracy and ease of manipulation it is almost essential that the tube-stand be attached to the table, moving freely and easily at the side. With this type of table the tube-stand can be fixed so rigid that there is no possibility of any movement of the patient altering the position or angle of the tube. It is quite essential that the end of the compression cylinder be equipped with a convex aluminum cap. This sinks deep into the soft parts and displaces denser material; it also sometimes forces aside gas which may be present in the colon. If the diameter of the cylinder is more than 5 inches at a distance of 13 inches from the target, the plate will be very little clearer than if no cylinder at all were used.

Again, in practice, I proceed as follows: The patient's knees are flexed. An 8 by 10 plate is placed crosswise under, say, the right side, so that its lower edge is about even with the umbilicus. The tube is then adjusted over a point midway between the umbilicus and the ensiform cartilage. The cylinder is then tilted between 5° and 10°, so as to point toward the right. At this angle it is lowered onto the patient slightly to the right of the median line, brought down with a fine adjustment device as tight as the patient will easily allow, and fixed so that it cannot be raised. The cylinder is now tilted about 10 to 25 degrees to point up under the ribs, and fixed in this position, and pushed up under the ribs as far toward the patient's head as he will allow, and fixed in this position. Finally, the tube and cylinder, sliding on the horizontal arm of the tube-stand, are moved as far towards the right as the patient will allow, and fixed in this position. This last movement will pull the ribs over to a considerable degree and it is necessary to instruct the patient not to turn toward the right side, and not to allow his back to slip on the table with an inclination to follow the movement of the tube. With everything fixed and rigid, the exposure is made.

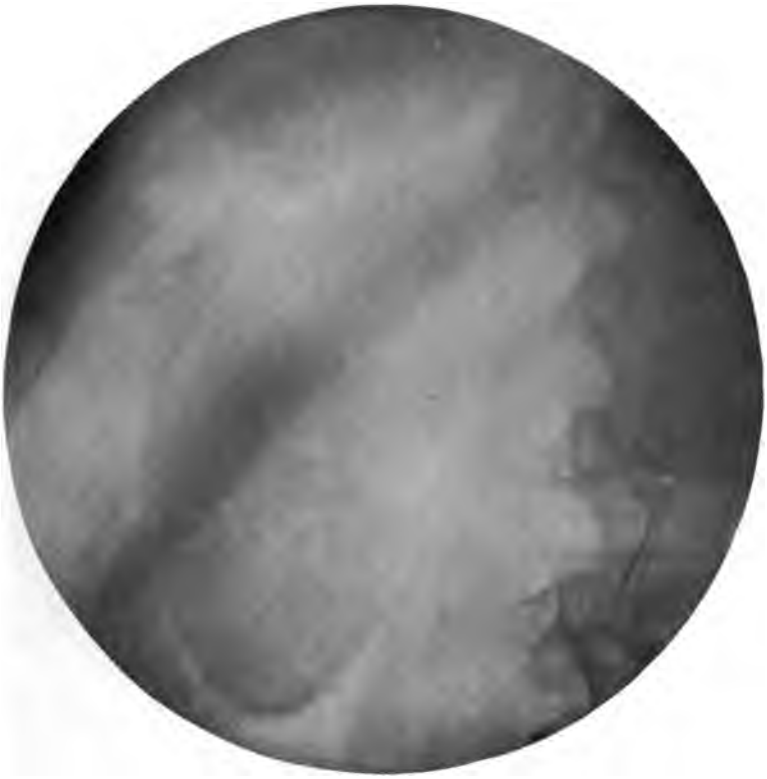

FIG. 3. NORMAL KIDNEY SHADOW—LEFT.

While the preparation of the patient is important, it is not essential in every case.

In patients who are not constipated or subject to gas formation in the colon, the examination may be made successfully without previous preparation; however, it is best in every case, when circumstances permit. This preparation consists of a thorough laxative the night before and an enema, as nearly as convenient, immediately preceding the examination. The importance of this cannot be too strongly emphasized in many cases. The kidney outline cannot be clearly brought out if there is a big gas pocket in the colon immediately over it.

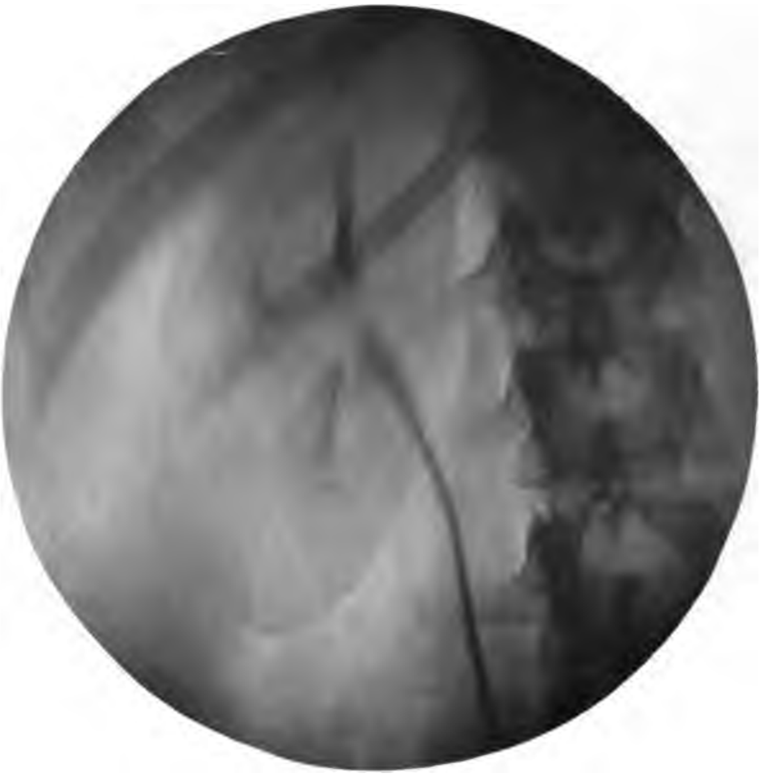

Fig. 4. Kidney Injected—Catheter in situ. Note the Blurring Effect of Incomplete Respiratory Control.

In this connection a word as to the kind of patient who is most favorable for this work might not be amiss. The most favorable type is the rather fat, small individual. In such a case we have an ample bed of perinephritic fat much less dense than the kidney substance and supplying the contrast that is so desirable. For this reason even large, fat patients often prove easier than small, lean ones. But, large or small, fat or lean, the kidney outline can be brought out.

It has been customary to dismiss the point of the patient's respiration simply by saying, "instruct the patient to hold his breath during the exposure." If the doing were as easy as the saying, it would need no further comment, but it is not. Many patients find it quite difficult to stop breathing entirely, even for five or six seconds. Many think that they are holding their breath when they are not. Place a mirror on the abdomen of such a patient, and while he is trying to hold his breath the reflection from the mirror will continue to sweep back and forth upon the ceiling. Such patients need instruction in holding the breath and close watching during the exposure.

The kidneys move more than we realize during respiration. This movement is from one-half to one and a half inches. A movement of only one-quarter inch will convert the shadow of a round stone into a long one, cause us to miss a small stone entirely, and completely obliterate any well-defined kidney outline.

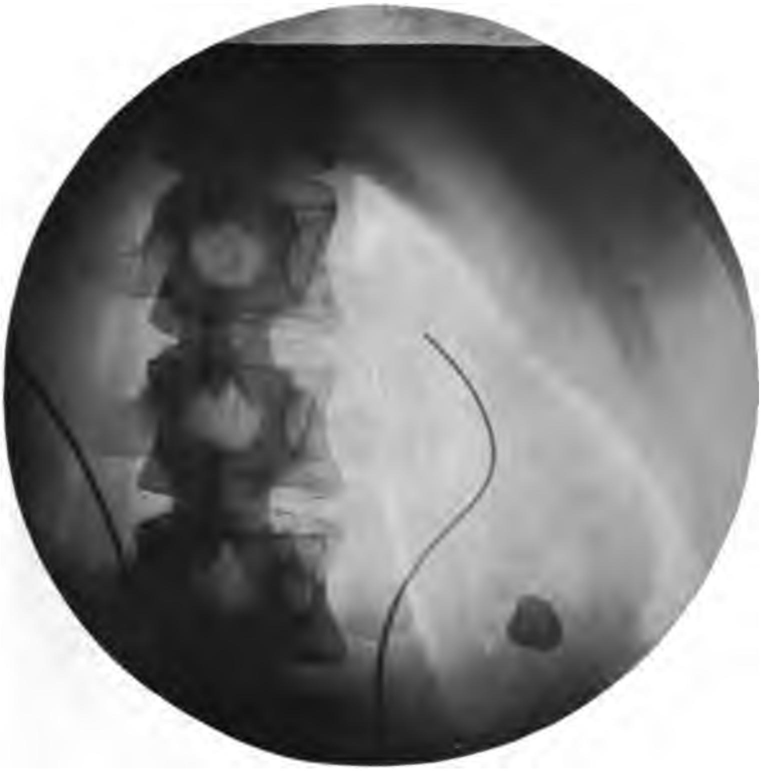

FIG. 5. KIDNEY OUTLINE, WITH STONE IN LOWER POLL. CATHETER IN SITU. NOTE THE SHARPNESS OF THE CATHETER SHADOW, INDICATING COMPLETE RESPIRATORY CONTROL.

SUBPHRENIC PNEUMOPERITONEUM*

PRODUCED BY INTRA-UTERINE INSUFFLATION OF OXYGEN AS A TEST OF PATENCY OF THE FALLOPIAN TUBES IN STERILITY AND IN ALLIED GYNECOLOGICAL CONDITIONS

BY I. C. RUBIN, M.D., F.A.C.S.

NEW YORK CITY

THE production of pneumoperitoneum by the method of insufflating the uterus with oxygen is intended to serve the specific purpose of testing the patency of Fallopian tubes. When the tubes are patent the gas passes into the peritoneal cavity, establishing an artificial pneumoperitoneum. This is detected by fluoroscopic examination. When occluded, the gas fails to reach the peritoneal cavity. In this failure to establish a pneumoperitoneum by the uterine route is furnished a fact of diagnostic value important particularly in the problem of the sterile woman.

Comparison of the Abdominal and Uterine Method of Producing Pneumoperitoneum.—This method cannot enter into competition with the production of pneumoperitoneum by abdominal puncture because of certain natural and pathological limitations. 1. It is obviously limited to women. 2. It is not applicable to all women, particularly the unmarried. Conditions such as pregnancy, menstruation and pelvic inflammation contraindicate for the time being its use. The method by abdominal puncture may be employed in the presence of nearly all these conditions without regard to uterine function. In cases where the uterus may be properly insufflated and the tubes are patent, it is of course possible to fill the peritoneal cavity with any desirable quantity of oxygen, in which case it may also serve as an aid in general abdominal diagnosis. This I have done in several cases at the request of colleagues in the medical and surgical services of Mt. Sinai Hospital. It may only be mentioned here that it can be done very simply without occasioning any appreciable sense of discomfort to the patient and involves no special surgical experience. It is not my purpose to advocate it either to substitute or to supplant the abdominal puncture method for general abdominal diagnosis. I am interested chiefly and practically in the aid it may render in clearing up the etiology of sterility in women.

In the problem of sterility a negative result is of equal importance with a positive result. Both prognosis and therapy depend upon whether Fallopian tubes in any given case of sterility are open or closed. I have elsewhere[1] pointed out that if we could demonstrate beforehand that the tubes are occluded a great many operations on the cervix of the uterus would not be undertaken. Instead of operating in such case upon the lower end of the uterus with a fruitless result, the patient remaining sterile and hoping against hope of becoming a mother, proper therapy would consist in immediately opening the abdomen with the object of freeing the tubes and doing some adequate plastic operation. Such operations have not infrequently resulted in curing sterility. Whether or not this type of operation is consented to, we are at least in the position to tell the patient from the very outset what her chances are for becoming a mother. Much time may be saved for those women who would gladly submit to a corrective operation at the very beginning were we in a position to locate the obstacle to conception at the true portion of the genital canal.

A word as to the *limitation of the abdom-*

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[1] *Journal American Medical Association*, Sept. 4, 1920. Paper read before the Section of Obstetrics and Gynecology at the seventy-first session of the American Medical Association.

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

inal puncture method and its ability to demonstrate patency or occlusion of the tubes. It has been possible to outline the uterus, tubes and ovaries, inclusive of tumors of these organs and inflammatory conditions in the pelvis, by forcing the oxygen through the abdominal puncture into the pelvis in the extreme Trendelenburg posture. In a very limited number of instances one may be fortunate enough to succeed by this method in demonstrating the fimbriated end of both tubes distinct from the ovaries and the uterus. In the abscence of adhesions one might assume them to be normal. In the presence of tumor masses it is not so easy to distinguish between the tube and ovaries, nor are we always fortunate enough in separating the shadows of distorted and dislocated tubes from adherent and overlying ovarian tumors, or from pelvic abscesses and tumors of the uterus. One need but recall in this connection the difficulty of distinguishing structures in pelvic inflammations when the abdomen is opened. Also the demonstration of bilateral masses by the shadowgram does not preclude actual patency of one or both tubes. It is absolutely possible to determine this fact by the method of intra-uterine insufflation of oxygen. I have on several occasions been able to demonstrate patency of the tubes in the presence of bilateral adnexal masses and at the same time establish that the lesion involved the ovaries alone. If in the presence of pelvic masses the gas fails to produce a pneumoperitoneum it may be safely concluded that the tubes are diseased and occluded at some point of their lumen.

Whether or not gross lesions in the pelvis may be more accurately outlined and interpreted by pneumoroentgenograms than by physical examination, *the matter of patency or non-patency is specifically established by the patency of the tubes to oxygen.* This point has hitherto been a matter of clinical speculation defying the skill of the expert in physical examination. The only way by which this fact could formerly be established was by actual laparotomy with inspection of the tubes, palpation, probing them with a sound and inflating them from the fimbriated end, a practice advocated notably by English gynecologists.

The value of the method as a practical test in cases of sterility may perhaps be illustrated by the following two cases:

Case I. A patient married three years and sterile; upon pelvic examination she was advised to be operated, and a dilatation of the cervix, curettage and stem pessary insertion were subsequently performed. Four days following this operation I was requested to test the patency of her Fallopian tubes. The method employed by me resulted in failure to establish a pneumoperitoneum. Laparotomy the same day revealed the fact that both tubes were closed at the fimbriated end. They were only slightly distended, their walls were flaccid and they were surrounded by soft, cobweb adhesions—in other words an old standing bilateral hydrosalpinx. The operation on the cervix in this case was certainly fruitless and could have been avoided by a preliminary examination with oxygen.

Case II. A patient married five years, sterile, no pelvic lesion demonstrable to account for the sterility. Insufflation of the uterus with oxygen on three occasions (with and without pressure control) failed to establish a pneumoperitoneum. She was advised to have a laparotomy performed in the endeavor to remedy the occlusion. This advice she apparently did not heed because some months later she had a curettage and Dudley operation, following the advice of a physician who assured her that to become a mother all she needed was to have her womb "stretched." The lesion in her case could not have been very pronounced at any time, eluding detection by the palpating finger, because the operation was performed by a gynecologist of considerable experience and one who must have concurred in the opinion of the general practitioner.

Safety of the Method and Advantages Over Exploratory Laparotomy.—Notwithstanding theoretical objections, all of which I have carefully considered in first contemplating the method, it has proved in my hands an absolutely safe procedure. Thus far I have had occasion to employ the method in 150 cases. As some of the cases were re-examined for purposes of corroboration, the total number of examinations was 170. In no case was there any evidence of injury or of infection. The cases were all observed carefully for a period of several months.

Compared to an exploratory laparotomy for the specific purpose of determining the patency of Fallopian tubes, it has several superior advantages, not the least of which is the economic advantage of saving the patient from the usual period required for post-operative convalescence. The method may be employed as a routine measure in one's office and the patient loses no time in laying up, has none of the discomforts and morbidity attendant upon a laparotomy. I am not discussing the question of mortality, assuming that that is practically nil in exploratory surgery. The method proposed by me should never result in mortality. The one theoretical possibility of fatality resulting is offered by the occurrence of embolism. This I have satisfied myself, by experimentation upon the extirpated uterus and in the living animal by direct intravenous insufflation of oxygen, can be dismissed from practical consideration. This accident and that of infection have not occurred in my series of cases, and infection should never occur when the procedure is adopted in properly selected cases and for the specific object of testing the patency of Fallopian tubes.

Contraindications.—The uterus should not be insufflated with oxygen in the presence of pus pouring down from the cervix, in the presence of fever caused by pelvic inflammation, in the presence of acute bartholinitis, urethritis or vaginitis. It is not advisable to use it during menstruation or any irregular uterine bleeding.

Ideal to be Sought in the Use of the Method.—By this I mean that we should be able to employ it in the office as a routine procedure for diagnosis comparable to cystoscopy and ureteral catheterization, occasioning no more and possibly less pain and discomfort than obtains in the urological examination. One of the chief aims is to make the method tolerable to the patient. It should not require the use of an anesthetic. So far I have not had to resort to any. It should take a short time, a minute or two, at the most three. It should be followed by very slight symptoms and not interfere with the daily duties and usefulness of the patient. To accomplish this, it is necessary to produce what might be called a miniature pneumoperitoneum confined in the erect posture to the subphrenic space. The smallest amount of oxygen sufficient to show distinctly through the fluoroscope should be injected. I have found in developing the method that from 100 to 150 c.c. of oxygen suffice to establish the subphrenic pneumoperitoneum. The most favorable time for the test is in the post-menstrual stage, in the interval of apparent functional quiescence.

Technique.—The armamentorium consists of an oxygen tank connected with a water bottle, the rubber stopper of which is perforated at three points through which bent glass connecting tubes pass. (Fig. 1.) One of these glass tubes is connected directly with the oxygen tank and dips down below the water level. The two other glass tubes dip down one or two inches and do not reach the water level. One of these is attached by rubber tubing to a mercurial manometer and the other is attached in the same way to the metal cannula. This metal cannula is of the Keyes-Ultzman type and is perforated at the tip by several small apertures. (Fig. 1.) A single tenaculum or bullet forceps, a uterine sound, a dressing forceps and bivalve vaginal speculum complete the apparatus. A rubber urethral tip is fitted over the metallic cannula to a point 1½ to 2 inches away from the cannula tip.[2]

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[2] Recently at the suggestion of my friend Dr. E. D. Oppenheimer I have adopted a simple device for measuring the volume of the gas and hope to describe it in the near future. It is made by courtesy of Wallace & Tiernan, 349 Broadway, New York City.

The volume of gas entering the uterus and eventually into the peritoneal cavity may be measured by displacing water and taking the time—interval measured in minutes. The average amount of water displaced should not exceed 250 c.c. per minute nor be less than 50 c.c. per minute. The rate of flow determines the pressure. The rapidity with which this rises I have found to be best limited to a 10:15 second interval for 100 millimeters mercury. At this rate from approximately 250 to 150 c.c. of oxygen is released per minute. This is determined previously by pinching the rubber tubing with the needle valve shut, allowing the gas to pass through at the rate fixed by the water displacement. With the gas flowing at this rate it may now be introduced into the uterus. The cervix is wiped clean and painted with iodine. A single tenaculum hook grasps the anterior lip. The cannula is introduced into the uterus well above the internal os and the urethral rubber tip is pushed well into the external os so as to render it air-tight. The gas is allowed to escape during this maneuver through the needle-valve release; the pressure is therefore atmospheric. As soon as the cannula is well secured within the uterus the needle valve is closed, allowing the oxygen to be insufflated within the uterus. Almost instantly the pressure rises. When the cannula is fixed within the uterus the patient is raised in slight Trendelenburg position and the vagina is filled partly with water to show any escaping gas from the cervix. This is not always necessary and should only be done in doubtful cases.

Pressure Reading in the Case of Patent Tubes.—The mercurial pressure rises to at least 40 mm., more often to from 60 to 100, with a slight momentary fluctuation possibly at that point, when it drops quite sharply 20 to 40 or even 60 points, which latter level it maintains more or less until the cannula is removed. The time required for the pressure to reach its maximum point according to the recommendation as above described is usually 15 to 25 or 30 seconds. The rest of the time, say 30 seconds to 45 or 60 seconds, is allowed for actual inflow into the peritoneal cavity.[3] This will depend upon the time interval required for the initial rise to the maximum on the one hand and on the other upon the size of the individual.

If the individual is narrow-waisted and thin she does not require as much gas to produce the subphrenic pneumoperitoneum as would an ample-waisted patient. These matters one can learn to gauge after some experience. No hard and fast rule can be laid down for these variations. At most they are slight and offer no difficulty. The average amount of oxygen required in a thin individual is from 75 to 100 c.c. In a stout woman it is well to use from 150 to 250 c.c.[4]

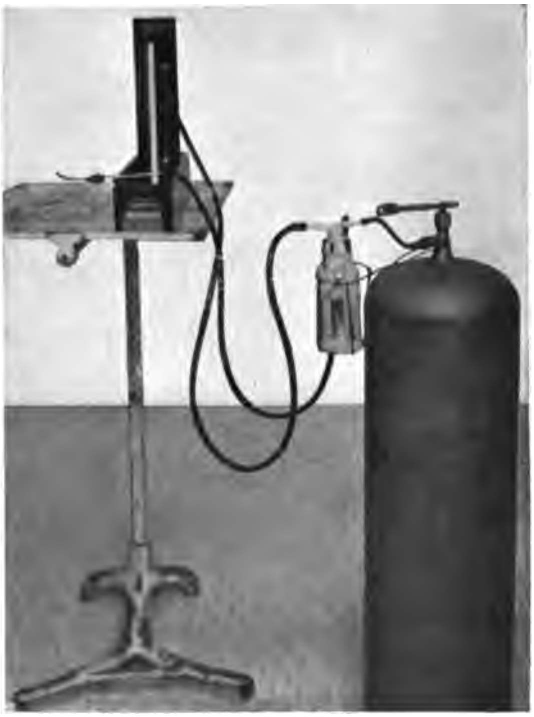

FIG. 1. THE APPARATUS ASSEMBLED. Note the Relief (Needle) Valve. This relief valve may be at any point in the outlet tube in case the tycos type of manometer is employed.

Pressure Reading in the Case of the Non-

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[3] The siphon meter of the Wallace & Tiernan type records the volume passing through automatically.

[4] When CO_2 is employed the quantity may because of its rapid absorption exceed these figures several fold.

Patent Tubes.—The pressure rises steadily, reaching 200 within 30 to 45 or 60 seconds. The pressure should not be allowed to exceed 250. It is maintained at between 200 and 250 for at least another minute if possible. This can be done by regulating the needle valve to permit a slight escape of the gas. In my experience so far a pressure of 200 or more, provided the rate of flow does not exceed 250 c.c. per minute, proves fairly conclusively the presence of tubal obstruction. This may of course be within the uterus itself, the blockade being at the uterine ostiae of the tubes, or it may be at any point along their lumen. When the rate of flow exceeds 250 c.c. per minute the initial rise may occasionally read 200 mm. or more before the gas passes into the Fallopian tubes and thence into the peritoneal cavity. The physics thus expressed is only from practical tests. Exact computations have as yet not been made.

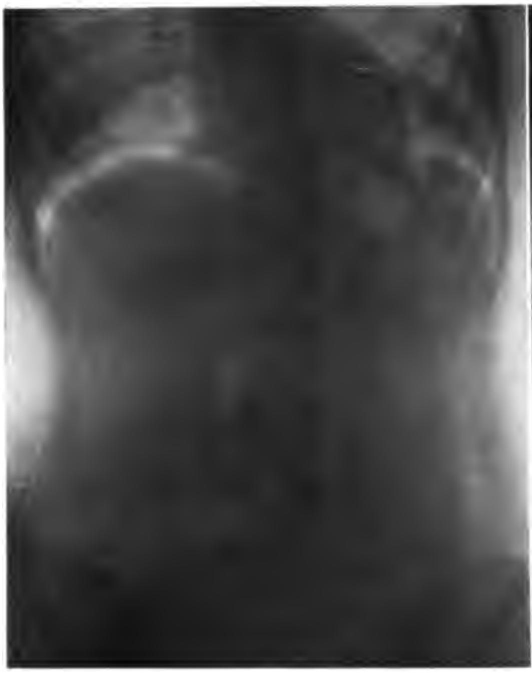


FIG. 2. SUBPHRENIC PNEUMOPERITONEUM. 250 C.C. OF OXYGEN INSUFFLATED THROUGH THE UTERUS AND FALLOPIAN TUBES. Diaphragm distinct on the right side; not visible on the left.

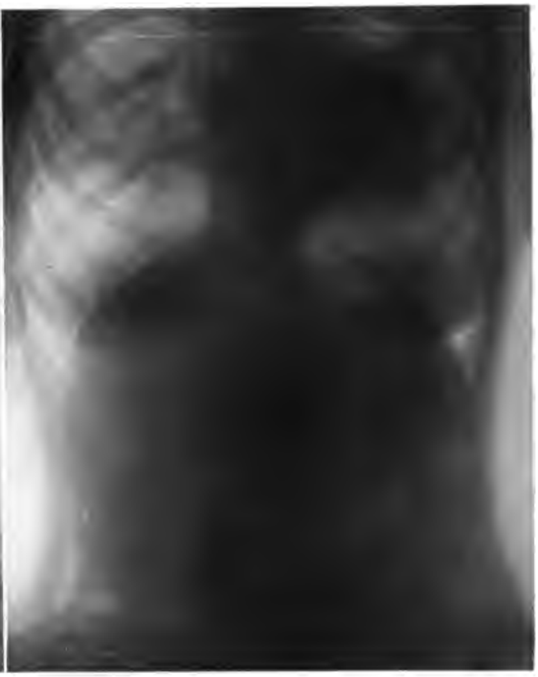
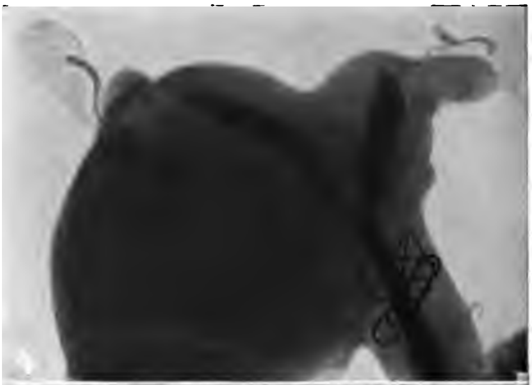


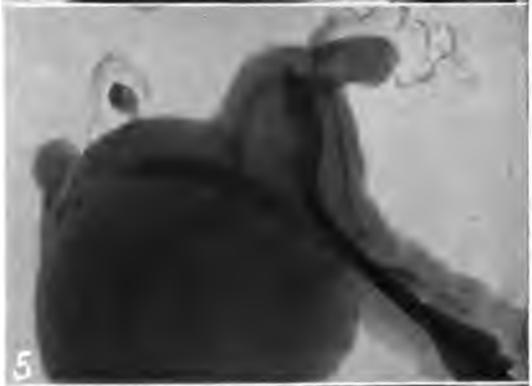
FIG. 3. SUBPHRENIC PNEUMOPERITONEUM. 1500 C.C. OF OXYGEN INSUFFLATED THROUGH THE UTERUS AND FALLOPIAN TUBES. Diaphragm distinctly visible on right and left sides. Abdominal viscera displaced to a considerable depth. For the purpose of demonstrating patency of the Fallopian tubes one-fifteenth of this amount is sufficient and satisfactory in the majority of cases.

SYMPTOMS. 1. *During the Oxygen Insufflation.*—The introduction of the cannula is attended in most cases with slight pain. Grasping the anterior lip of the cervix by the single tenaculum hook is noticed scarcely, if at all, by the patient. The actual insufflation in the patent cases seldom causes pain. When the initial pressure exceeds 100 the patient may complain of a sensation of fullness or bearing down or occasionally she may feel as if she were unwell. In the non-patent cases with the pressure rising to 200, cramps are occasionally complained of, now in the suprapubic region and now in one or both sides. Since the time required for insufflation is the short interval of one or two minutes, practically every case can tolerate it. I have had practically no failure due to intolerance during the examination. A nervous patient will sometimes defeat the completion of the test, but even she can be reassured and will submit to it at another time. That will happen once in 50 or 100 times.

2. *After the Oxygen Insufflation; Fluoroscopy. In the Patent Cases.*—Inasmuch as the patient is instructed to stand up immediately on withdrawing the uterine cannula, the oxygen gas rises almost instantaneously to the region of the diaphragm. It occupies the subphrenic space for a depth of ¼ to 1 inch or more depending upon the amount insufflated. (Fig. 2.) Within two or three minutes if not sooner (just as soon as the patient can be set up before the fluoroscopic screen) the transparent "gas" area may be seen under the diaphragm. The liver on the right side is seen displaced in a downward direction. Not infrequently the gas may be localized to one or the other side, but as a rule the diaphragm may be seen lifted above the underlying abdominal viscera from right to left. It is discernible as a transverse septum and is unmistakable. When the subphrenic pneumoperitoneum is not at once visible the patient is instructed to lie on her right or left side for a few minutes, after which the gas will show clearly on one side or the other.

It is not necessary for the purpose of testing the patency of Fallopian tubes to fill the peritoneal cavity with a large volume of gas in sufficient quantity to "visualize" the abdominal viscera, as in Figure 3. The symptoms in such a case are rather distressing and this is obviated by reducing the pneumoperitoneum to its diminutive. With 75 to 100 c.c. of oxygen under the diaphragm the secondary symptoms are almost negligible. Slight sticking pains between the shoulder-blades or in the shoulders themselves are noticed by the patients. There is no abdominal distress, and if at all present it amounts to a slight sense of discomfort about the diaphragm. The vast majority of the patients leave the office and continue in their ordinary daily routine. Some patients may require to lie down with feet elevated for a few hours. As, according to Alvarez, carbon





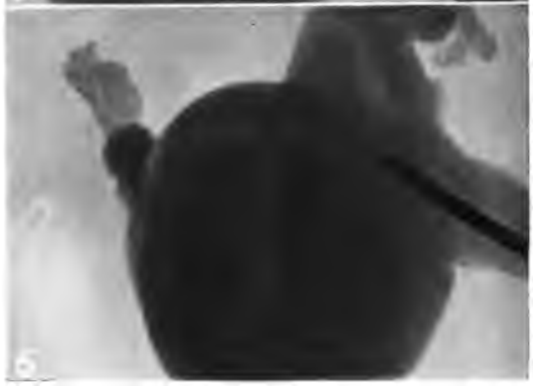


Fig. 4. A Bicornuate Uterus. Thorium injection. The tubes are closed by a ligature at the fimbriated end. Note the definite clubbed outline of the tube at point of ligature and the narrow caliber of the intramural portion.

Fig. 5. The Same Specimen as in Figure 4. Skiagraphed during thorium injection with the ligature removed allowing the solution to escape through the fimbria. Note the irregular and overlying shadows.

Fig. 6. Skiagraph of the Same Specimen as in Figures 4 and 5. Oxygen injection. Note the faint shadows in the horns of the uterus and the absence of any contrast shadows within the Fallopian tubes.

dioxide gas is more rapidly absorbed than oxygen, it may be well to use it and reduce the secondary symptoms to a negligible minimum.

Immediately on withdrawing the uterine cannula there may be a slight regurgitation of oxygen with a slight oozing of several drops of blood that is readily checked by a sponge applied to the cervix. It is negligible and gives no further trouble. By selecting the post-menstrual period for the test one can avoid even this slight oozing.

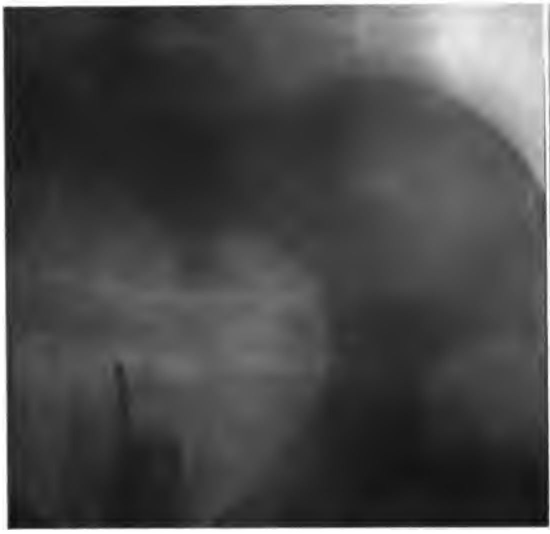


Fig. 7. Case of Ablated Tubes; Large Uterus—40 c.c. of Oxygen Injected into the Uterine Cavity. This is seen transversely pear-shaped. The speculum, cannula and Thomas pessary are also seen.

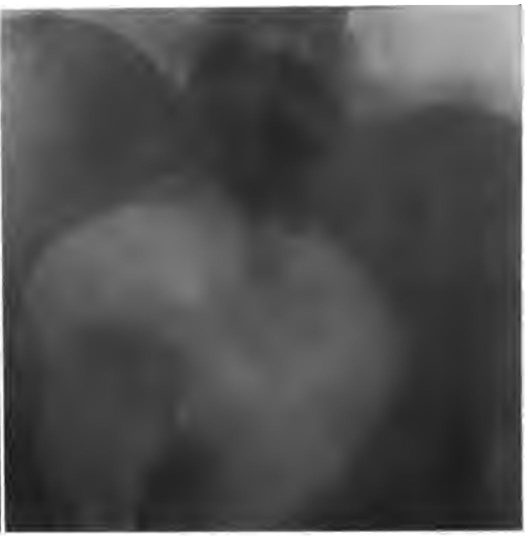


Fig. 8. Same Case as in Figure 7. 40 c.c. Thorium Injected into the Uterine Cavity.

In the Non-Patent Cases.—Beyond the temporary discomfort produced by the insufflation there are no further symptoms. The cramps may continue for a minute or two or perhaps five and then subside. None of the referred shoulder pains are complained of and there is no epigastric oppression. The oozing is almost as slight as in the case of patent tubes; the oxygen regurgitation may be more evident. The non-patent tube cases are perfectly comfortable after the test and leave the office to go about their duties as freely as before.

It is well to mention here that I have made it a rule to repeat the test at least once in the non-patent cases to check up the findings at the first examination. With the apparatus properly adjusted in each case the findings will be found to corroborate each other at the second test. Occasionally, however, there may be an error in technique which will invalidate the conclusion. Most scrupulous attention should be given the possible points of leakage along the entire apparatus.

While in the positively patent cases there may have been some regurgitation, nevertheless when this occurs and the gas does not enter the peritoneal cavity we are left in doubt and must, if need be, repeat the test several times. If regurgitation takes place each time it is highly probable that there is an obstruction within the uterus which is responsible for it. On the other hand, oxygen may escape from the cervix and a sufficient quantity nevertheless reach the peritoneal cavity as may be determined by the fluoroscope.

Anatomical Consideration in Relation to the Test.—The ideal case for the test is one in which there is no thick tenacious plug present, in which the external os is round and intact, the uterus not sharply angulated. In such cases the cannula (ordinary size) enters easily and obturation is more perfect. When the uterus is sharply flexed forward or backward it is necessary to shape the cannula accordingly so that it may enter the uterine cavity to a point above the internal os. When the external os is gaping and torn as obtains in certain cases of relative or secondary sterility it may be necessary to secure better obturation by grasping the two lips of the cervix with a bullet forceps. The internal os, however, is intact even in these cases and as the cannula is introduced beyond it the ordinary cannula insures satisfactory obturation. A mucus plug should be cleaned out and the cervical canal painted with tincture of iodine.

When the external os is narrow it is necessary to use a cannula of correspondingly smaller caliber or it may be advisable first to dilate it gently to proper width.

Occasionally obstruction is encountered near the internal os. Here of course the test cannot be carried out. This is an incidental finding which has particular significance in the problem of sterility for that given patient. In such case it is first advisable to overcome the stenosis by proper dilatation and then later on the oxygen insufflation may be tried. I have had two such cases in my series.

Uterine Insufflation of Oxygen Compared to Intrauterine Injection of Solutions Opaque to the X-Ray as a Test of Tubal Patency.—My experience with the injection of solutions opaque to the *x*-ray included collargol, thorium and bromide. All of these are useful when the tubes are occluded. (Figs. 4 and 8.) When the tubes are patent the roentgenograms are not uniformly satisfactory because the solution escapes into the peritoneal cavity and not enough of it is left to show in the tube lumen. (Fig. 5.) Collargol leaves deposits in the tubes which may or may not be absorbed. Thorium and bromide in solution do not leave precipitates. Peritoneal irritation by chemical action with consequent adhesions is a possibility to be borne in mind. Whether or not this may be the case, an objectionable feature to the use of the solutions is the uterine colic, accompanying and following the injection. Patients do not tolerate this so well. In this one respect the oxygen insufflation has a particularly superior advantage. Any residual oxygen within the uterus is immediately expelled with the removal of the cannula. The other advantage of no less importance is that the oxygen is readily absorbed by the tissues and does not leave irritative precipitates. Only exceptionally will one encounter a uterus that may be called irritable to the oxygen. It is more apt to be in a very nervous woman. In my experience with the oxygen insufflation I have succeeded in completing the test in every case, although in two instances I had to defer the test for another time owing to apprehension on the part of the patient. It is conceivable however that in cases of endometritis and perimetritis of more recent date the uterus will be tender to the manipulation.

Oxygen does not show in the tubes when patent. In the anatomical specimen it may show very faintly in the skiagraph (Fig. 6) when the tubes are ligated at the fimbriated end but not in sufficient density to appear in the living subject where the contrast is obliterated by neighboring shadows, etc. Occasionally in a case where both tubes have been removed and the uterine cavity is large, having a capacity of 40 to 50 c.c., one may succeed in getting a good outline picture with oxygen. I have had one such result. (Fig. 7.) Our experience in attempting to demonstrate the oxygen in uteri during the injection with the exception of this one case has so far not been satisfactory although we have not made a persistent effort in this direction.

Conditions in which the Intra-uterine Oxygen Insufflation Method Has Been Found Useful.—1. Primary and absolute sterility of several years' duration with no gross lesions ascertainable. This is the ideal group for the test.

2. Sterility of long standing where pelvic

masses are palpable and clinically diagnosticated as fibroids or "chronic diseased adnexa." The test shows whether or not the tubes are open.

3. Cases in which one tube was removed for inflammatory disease or for unilateral ectopic to determine the normality of the lumen of the residual tube.

4. Cases in which there is a history of an attack of appendicitis with peritonitis in the premarital or postmarital state to exclude tubal occlusion by a residual adhesive peritonitis.

5. Cases following a pelvic exudate or abscess with or without operation and where apparent resolution has taken place and yet sterility is complained of.

6. To test the probity of the tubes in cases where tubal ligation was done with the object of permanent sterilization.

7. To test the continuity of the genital canal in cases where the conservative operation of myomectomy, single or multiple, was done in the hope of relieving sterility.

8. To test the result of plastic operation on the tubes in cases of bilateral salpingostomy.

A detailed account of these results will be taken up in a clinical consideration of thc problem of sterility.

CONCLUSION

The method of intra-uterine oxygen insufflation to produce an artificial pneumoperitoneum establishes the fact of patency or occlusion of Fallopian tubes. Under manometric and volumetric control it is a scientific, diagnostic procedure and may be employed with safety to determine the mechanical factor involved in the etiology of female sterility. For this purpose it obviates the necessity of surgical exploration and is specific.

As the fact of tubal patency is in most cases primarily a matter for speculation, its scope for general abdominal diagnosis as compared to that offered by the direct abdominal puncture metohd is necessarily limited. In cases where the tubes are patent, however, a pneumoperitoneum of any size may be produced by the uterine route.

For the definite object of establishing tubal patency by intra-uterine insufflation, only a diminutive amount of gas is necessary because the result desired is to produce a localized subphrenic pneumoperitoneum which shall be followed by scant if any symptoms. The vast majority of the patients tolerate this method very well and it may be employed as a routine office procedure. The use of carbon dioxide instead of oxygen will diminish the symptoms following insufflation almost to a vanishing point. It is well however to bear in mind the primary object of the test and to apply it only in cases properly suited for its use. In these it has proved of great diagnostic and prognostic value.

In 150 cases, with a total of 170 examinations, there have been no untoward sequelae.

THE DETECTION OF RETROPERITONEAL MASSES BY THE AID OF PNEUMOPERITONEUM

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THE wider use of pneumoperitoneum as an aid to radiological diagnosis of abdominal conditions is fast bringing the subject from the stage of generalities to that of more special methods of examination.

The number of experiences encountered, even in the fifty pathological cases which we have had, is so large that it would seem more advisable and probably be more profitable to consider one of the groups into which these cases fall rather than to undertake a discussion of the subject in general. I shall, therefore, confine this paper to one of the groups of cases in which we have found this method of great aid; I refer to the detection of retroperitoneal masses.

Early in our experience with pneumoperitoneum, we encountered a case which proved to be of great value to us in developing a technique for the detection of retroperitoneal masses. I shall outline the case, as it presented itself. B. C., a well developed, colored male, age twenty-six, presented himself, with a slightly tender, very hard, smooth mass in the lower right quadrant of the abdomen. The case was the occasion of some dispute among the staff, as to whether the mass was attached to the kidney or not, and a pneumoperitoneum examination was made to try to determine its origin. By the ordinary antero-posterior plate, it was found that the mass was entirely free from both kidneys, and that it extended downward to the pelvis and across the midline, causing nearly as large a mass, as yet undiscovered, on the left side. In an effort to determine the relation of this mass to the ureter an injection of thorium was made into the kidney pelvis and a plate was made showing the smooth gentle curve of the ureter. A second plate was then made while exerting upward and inward pressure on the mass with a cone, and the radiograph showed a distinct kinking of the ureter, suggesting that the mass was retroperitoneal and that the ureter passed anterior to it. Destruction of the bodies of the 4th and 5th lumbar was noted, and the possibility of the mass being a tuber-

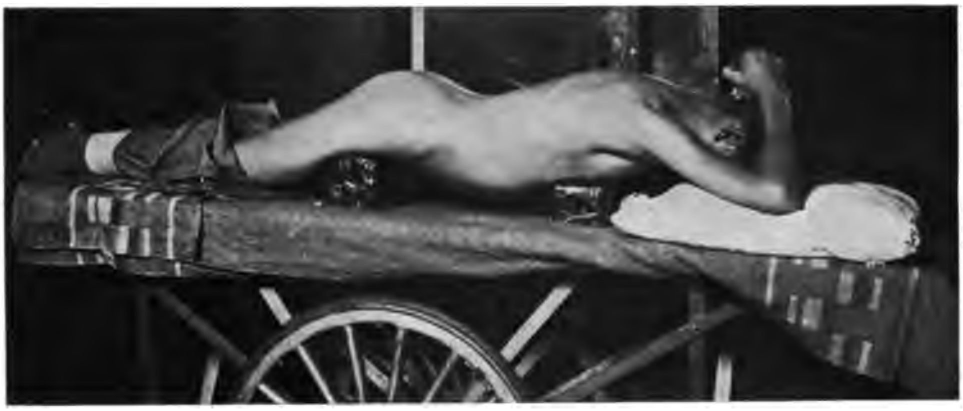


FIG. 1. RETROPERITONEAL POSITION. Patient Prone. Chest and thighs supported on two blocks, allowing the abdominal wall to sag freely without pressure.

cular abscess was at once considered. In an effort to demonstrate the origin of the mass more clearly, the patient was examined in a prone position (Fig. 1), chest and thighs supported on two blocks taking all pressure off the abdomen and allowing the anterior abdominal wall to sag freely between the two supports. The retroperitoneal character of the mass and its complete separation from the kidneys was then clearly shown (Fig. 2), and since the mass originated in the area of destruction of the lumbar spine, the diagnosis of psoas abscess was made, which was confirmed by subsequent developments.

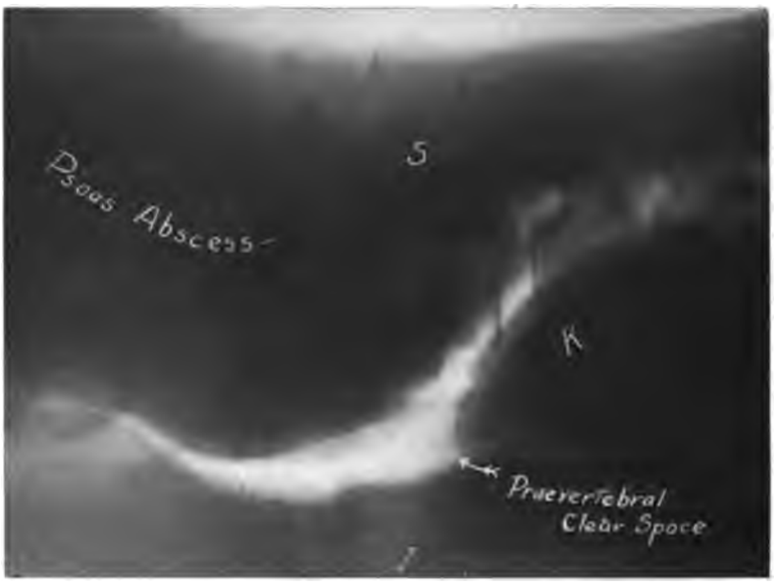


FIG. 2. PSOAS ABSCESS SHOWN IN THE RETROPERITONEAL POSITION ENCROACHING UPON THE PRAEVERTEBRAL CLEAR SPACE.

Since this prone position demonstrated the retroperitoneal origin of the tumor mass so clearly in this case, it was not long before we made a closer examination of its possibilities in other cases. A moment's consideration of the anatomical arrangement in this position may serve better to illustrate the cases which are to follow. (Fig. 3.) It will be noted that if the patient is suspended on two blocks, so as to take all pressure off the abdomen, the belly wall will sag down and all of the intra-abdominal organs with mesenteric attachments will fall forward leaving a clear space between them and the retroperitoneal structures. The liver is attached by the triangular ligament to the diaphragm, and drops forward also, to a greater or lesser extent in different individuals according to the location of this attachment, forming a triangular shadow with the apex at the diaphragmatic attachment. If the individual is normal this space should be clear; if

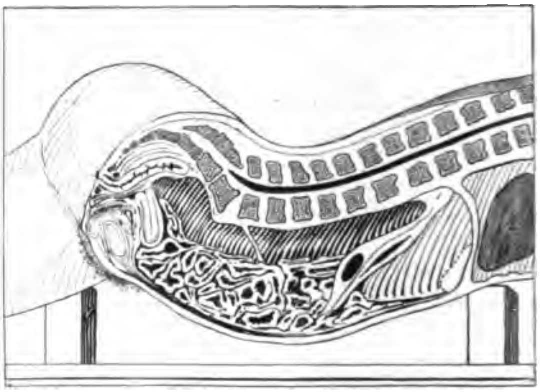


FIG. 3. THE PATIENT, PREVIOUSLY OVERDISTENDED, IS SUPPORTED UPON TWO BLOCKS, allowing the anterior abdominal wall to sag down freely. The intestines and all organs with mesenteric attachment have fallen forward, leaving a praevertebral clear space. Any retroperitoneal mass will encroach upon this clear space.

a retroperitoneal mass is present, this space is encroached upon. Figure 4 shows in a gross way the appearance of a normal individual in the retroperitoneal position. Note that the intestines and all structures with mesenteric attachment have fallen forward and that the prevertebral space is clear and not encroached upon. The liver shadow is seen with its diaphragmatic attachments.

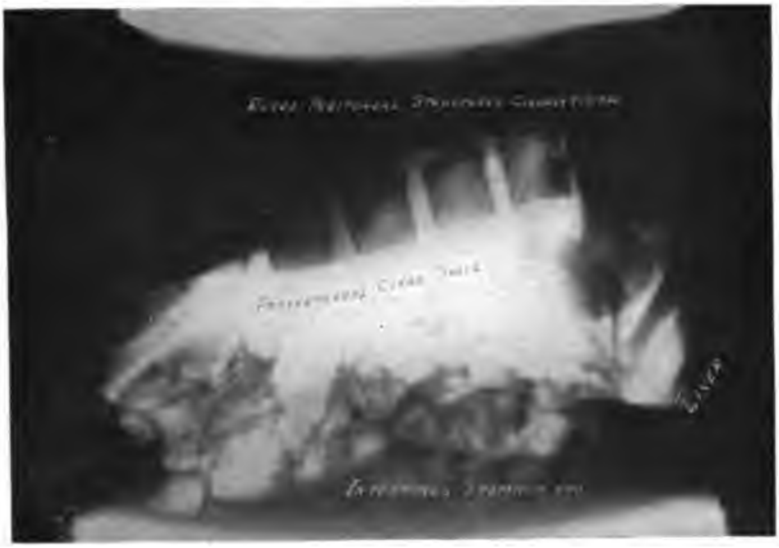


FIG. 4. RADIOGRAPH OF A NORMAL INDIVIDUAL IN THE RETROPERITONEAL POSITION. Intestines and organs with mesenteric attachment have fallen forward, leaving clear praevertebral area. Encroachment upon this space by a mass originating in the retroperitoneal tissues can be clearly seen.

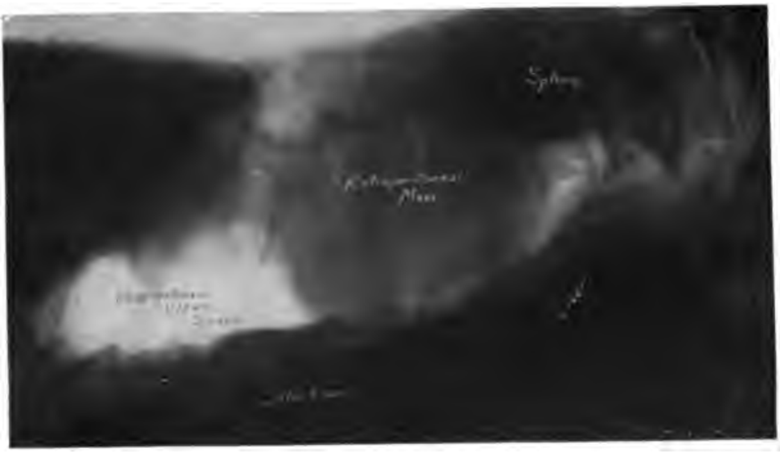


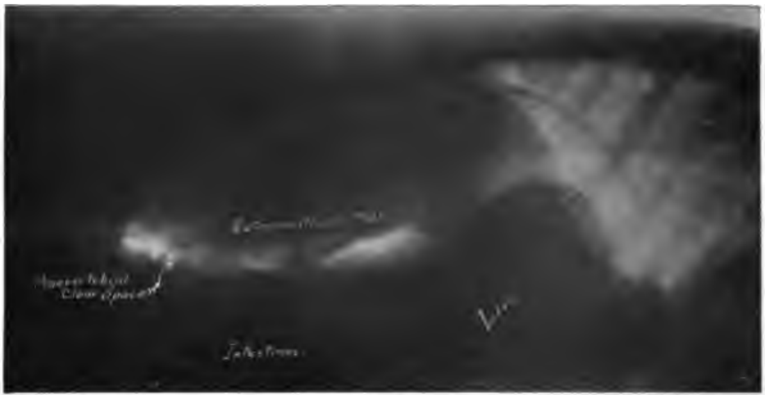
FIG. 5. NEW GROWTH OF LEFT KIDNEY SEEN IN THE RETROPERITONEAL POSITION TO ENCROACH UPON THE PRAEVERTEBRAL CLEAR SPACE.

To illustrate the value of this position let us proceed to the second case.

J. M., white, male, age thirty-two, presents on examination a large tumor mass on the left upper abdomen; not painful and moving only slightly, if at all, with respiration. On inflation the mass was seen to have no connection with the anterior abdominal wall, although it did protrude well forward and was represented by a shadow in the middle of the abdomen. An antero-posterior examination revealed the extent of the mass to be even greater than supposed and it seemed to go down into the pelvis. The liver was shown to be uninvolved.

An examination in the lateral position showed the spleen clearly separated from the mass but the left kidney could not be definitely outlined. In an effort to determine whether the left kidney was involved in the mass, the ureters were catheterized and 20 c.c. of thorium nitrate injected with the result that nothing more than a misshaped shadow appeared within the tumor mass.

To rule out a possible origin from the large bowel, a barium enema was given. The colon was perfectly normal and encircled the tumor without in any way being attached to or compressed by the mass. Lastly, as a final step in the pneumoperitoneal examination, the patient was put in the retroperitoneal position with Figure 5 as a result. The intestines, stomach and all organs with mesenteric attachment have fallen forward. The liver has dropped exceptionally far forward and the only organ which still remains in place is the spleen, which probably is adherent somewhat to the diaphragm, and which may also have been prevented from displacement by the shelf-like projection of the mass. The mass itself can be seen taking origin among the retroperitoneal tissues and extending forward to encroach upon the prevertebral space. Diagnosis of a new growth involving left kidney was made.



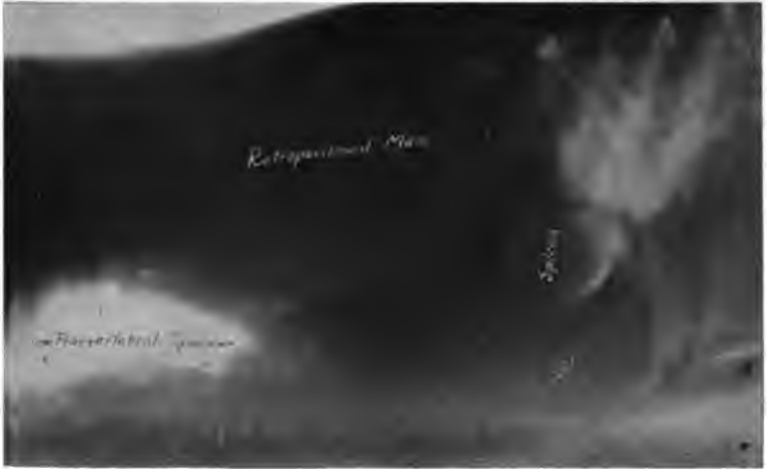


Fig. 6. (*Above*) Perinephritic Abscess Showing Diffuse rather Extensive Encroachment of the Mass upon the Praevertebral Space.

Fig. 7. (*Below*) Large Sarcoma of Kidney Shown in the Retroperitoneal Position to Encroach upon the Praevertebral Clear Space to a very Considerable Degree.

A third instance illustrating the advantage of this position will be seen in the case of M. S., white, female, age thirty-three, who presented on examination a palpable mass in the right lower abdomen which was very tender both on abdominal palpation and over the back, and was thought to be a movable kidney. Pneumoperitoneum examination revealed a diffuse, hazy mass on the right side below the liver and widely separated from it. Examination in the retroperitoneal position was made (Fig. 6) and a rather extensive obscurity of the retroperitoneal tissues was seen. The liver and all organs with mesenteric attachment have fallen forward, but the spleen is adherent and seen in its position in contact with the diaphragm. The mass encroaches upon the prevertebral space but seems to be more diffuse. Psoas abscess was considered but no carious vertebrae could be found. Tumor of the kidney was thought of, but a plate showing clearly the kidney outlines was obtained and the radiological diagnosis was a probable perinephritic abscess. Operation confirmed this diagnosis.

The fourth case in the study of this method of examination, was likewise very interesting. J. V., colored, male, age nineteen, presented besides an enormous abdominal tumor occupying the entire left side of his abdomen, innumerable small nodules under the skin all over the body. The abdominal mass seemed to move slightly with respiration and on first examination was thought to be the spleen. Antero-posterior view made by the aid of pneumoperitoneum at once showed the extent of the mass and showed its separation from the spleen. The lateral view also showed the mass to be very extensive, with areas of irregular density and an oval, more or less smooth outlined mass at the top. A small stringy-like shadow resembling the kidney pelvis was seen in the midst of the mass and on looking up the records of the case it was found that ten months previously there had been an injection of his kidney pelvis made with thorium nitrate. In this plate his kidney outline showed also very well, but since his complaint was the same it is quite probable that this was at the inception of his disease. The diagnosis was not made at that time. Finally examination was made in the retroperitoneal position (Fig. 7) and a large retroperitoneal mass was found projecting forward into the prevertebral

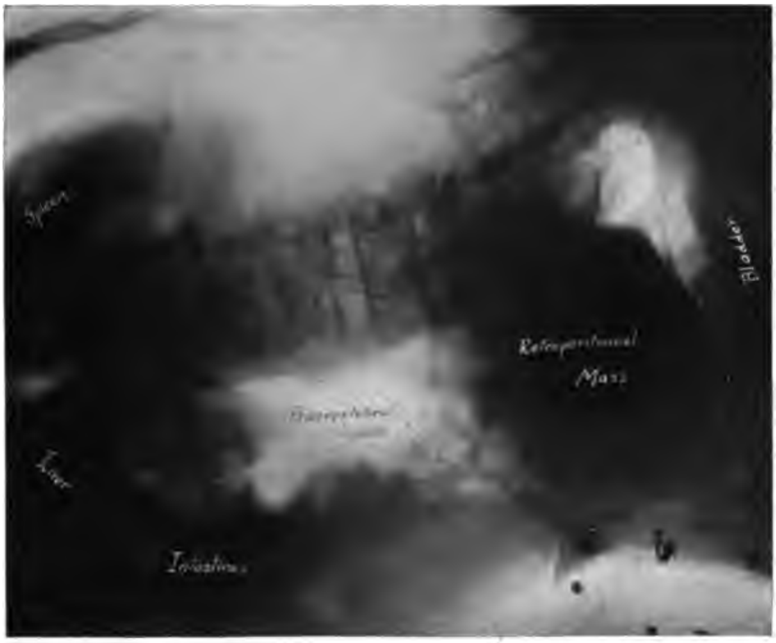


FIG. 8. RETROPERITONEAL CARCINOMA SECONDARY TO CARCINOMA OF THE BLADDER SEEN ENCROACHING UPON THE PRAEVERTEBRAL SPACE. Note the slightly rotated position necessary when dealing with retroperitoneal masses in the pelvis.

space and almost obliterating it. Diagnosis of tumor of the left kidney was made. Operation and pathological section established the diagnosis of sarcoma of the kidney.

When the pathological process is low down, so that the shadow of the mass falls below the shadow of the innominate bones, the patient, still in the retroperitoneal position, must be rotated slightly towards the side of the tumor, in order to get a view unobstructed by the crest of the ilium.

The following case presents quite clearly the use of the retroperitoneal method of examination in tumors low down or in the pelvis. F. L., white, male, age sixty, presented upon examination a large rounded tumor mass, arising just over the symphysis, and extending to the umbilicus. With frequent voiding of small amounts of urine and tenesmus, the patient looked very similar to one suffering from urinary retention from an hypertrophied prostate. Pneumoperitoneum examination was made and a large mass about the size of a child's head was seen almost completely to fill the pelvis. A dark shadow just above the symphysis was taken to be the collapsed bladder, and on injection this proved to be the case; the mass was separated from the bladder. A barium enema was given and the sigmoid was seen to run over the mass but was unobstructed in its course, and give the impression of a retroperitoneal mass, which had in its growth merely pushed the large bowel forward.

The patient was examined, slightly rotated in the retroperitoneal position (Fig. 8) and a large retroperitoneal mass was found, widely separated from the bladder. No bone destruction of spine or pelvis was found. Cystoscopic examination of the bladder was made and a carcinoma of the bladder was found. Diagnosis of retroperitoneal carcinoma, secondary to a carcinoma of the bladder was made.

To outline briefly the essentials for a satisfactory retroperitoneal examination:

1. It is especially essential when this examination is to be undertaken, to clean out the bowels well, using vegetable cathartics.
2. The patient should void his urine just before examination.
3. He should be given little if any food just prior to the examination.
4. He should be *over-distended* with the inflating medium.
5. He should be sufficiently well supported to exert no pressure on the interabdominal contents.

We have to date used this position in the detection of retroperitoneal masses with continued satisfaction and feel that it will ultimately be of great value for this purpose.

DISCUSSION FOLLOWING SYMPOSIUM ON ARTIFICIAL PNEUMOPERITONEUM

[In addition to Dr. Rubins' and Dr. Sante's articles in this issue of the JOURNAL, the Symposium includes the following: *Pneumoperitoneum of the Pelvis: Gynecological Studies*, by James G. Van Zwaluwenberg, M.D., January issue, p. 12. *Pneumoperitoneum as an Aid in Differential Diagnosis of Diseases of the Left Half of the Abdomen*, by A. F. Tyler, M.D., February issue, p. 65. *The use of CO_2 in Producing Pneumoperitoneum*, by Walter C. Alvarez, M.D., February issue, p. 71.]

DR. LEOPOLD JACHES. The roentgenologic method in connection with Dr. Rubin's work was developed by my associate, Dr. Bendick, and I have seen a relatively small proportion of these cases, but I can assure every roentgenologist here that it is a very easy procedure, that it doesn't take much time. There is no fuss about it. We have very frequently been able to do one or two or three cases between other fluoroscopies. There is absolutely no fuss at all.

I am not as pessimistic as Dr. Rubin is with regard to the possibility of determining which tube is patent and which is closed. It should not be very difficult to do so fluoroscopically during the time of the inflation.

We have not yet at the hospital a fluoroscope appropriate for this work, but as soon as our Dessane bonnet arrives we shall investigate this phase of pneumoperitoneum.

Dr. J. W. Hunter. I should like to inquire of Dr. Van Zwaluwenberg if pregnancy can be diagnosed by the pneumoperitoneum method unless the head or some of the bones of the fetus are shown on the plates. The reason I ask that is because I did not notice any on the slide which he showed us.

Dr. James G. Van Zwaluwenberg. With regard to the demonstration of pregnancy without the actual demonstration of bony parts of the fetus, I am very optimistic that we shall be able to do this because there must be differences in development and enlargement of the uterus from those of pathological enlargements. We haven't seen a great many of these cases, and I don't know positively whether that is so, but so far we have have had no myomata of the uterus which looked anything at all like pregnancy, and we have plates of one case whose last menstruation was six weeks before the examination, one which Dr. Peterson insisted was pregnancy, and the changes in the uterus are altogether characteristic. That is his opinion. I think there will be very little difficulty in differentiating the distortion of the uterus by a myoma or other enlargement from that of a pregnancy.

To Dr. Stewart, we owe a great obligation, because the idea of the work was directly suggested by some of the plates he showed at Saratoga. The objection he has met, we also are meeting. The Department of Gynecology has been the subject of considerable ridicule for using this method, on the ground that they should be able to make all their diagnoses without it. As a matter of fact, the gynecologist usually knows pretty well what he is going to find when he opens the pelvis, but the fact remains that sometimes he doesn't, as Dr. Rubin's case, in which there were double pus tubes which were not suspected, illustrates. The same sort of thing has happened in our experience. I doubt if the method will ever become routine. We are doing it routinely now until we have established a basis for our opinions, which, at this time, aren't worth a great deal, but I have great hopes that some system of standards can be established which will make this method of real use.

Dr. L. R. Sante. I noticed that Dr. Rubin referred to the pneumoperitoneum showing more on one side than on the other in these cases, and I would like to offer the following as a possible explanation: The mesentery of the small intestine, as we know, is attached on the posterior wall of the abdomen in an oblique position. I wonder if this does not act as a wall, thereby confining the oxygen more on one side of the abdomen or the other depending upon which tube is patent.

Dr. Rubin (closing). I am glad to have heard the explanations of the appearance of the unilateral pneumoperitoneum. I am quite free to say I did not think of all those things. It may very well be, though, because in the beginning we had the patient get off the table on one side or the other, and it is very likely that that occurred, but lately we have had the patient sit bolt upright, so that the explanations given could not be true in that event, and so some other explanation may be necessary. Dr. Sante's suggestion of the slanting mesentery may be true in some cases. On the other hand, as Dr. Stewart explained, the gas takes the path of least resistance and is influenced by the weight of the viscera. It may very well be that sometimes the stomach is heavier than the liver. As a rule, the liver is heavier than the stomach.

About the contra-indications: I would like to repeat them again. The presence of pus in the genital canal, urethra, vagina or cervix, and the presence of fever due to pelvic inflammation are contra-indications. Even though there is an inflammatory process, however, if there is no fever, that lesion is quiescent, and the introduction of 150 c.c. at 200 pressure will not do any harm. It will not do any harm when the fallopian tubes are closed, at least in my experience I have seen no harm result in such cases.

Another thing I want to consider is the theoretical possibility of the formation of embolism. I tested this problem out by actually introducing oxygen into the vein of a dog, and found that 350 c.c. of oxygen injected into the vein did not as it were cause the dog to "turn a hair." Now, if 350 c.c. of oxygen, which is the very maximum dose which I require for my patients, does not affect a dog by direct intravenous application, it certainly will not do any harm in the human.

I think someone asked about sterilizing the parts. The apparatus I use consists of speculum, tube, single tenaculum hook, and a cannula. These are, of course, boiled. The vagina is wiped clean of whatever mucus may be present, and the cervix touched with iodin.

DR. L. R. SANTE. The wider use of pneumoperitoneum in abdominal conditions has brought the subject from the stage of generalities to that of more special methods of examination. This you have seen to-day in the examination of the pelvic organs, by Dr. Van Zwaluwenberg, in the special examination of the spleen, and also, as mentioned by Dr Tyler, in the detection of abdominal masses. I am glad to hear, also, that Dr. Stewart spoke of the difficulty in differentiating kidney masses, and to see that he showed a case which he infers is a retroperitoneal mass.

When we first started this work about a year ago in the City Hospital in St. Louis, we were greatly handicapped to get a routine technique which would be at once rapid and sufficiently thorough to secure all of the necessary points in the examination. The number of positions in which it was necessary to place the patient was the greatest difficulty we had to overcome. We finally brought into use a type of hospital cart, balanced upon two wheels, so that mere pressure upon the cart at either end would raise or lower the head or feet. This we found most efficient.

When we first undertook this work we followed very closely the technique of the first writers upon the subject, using oxygen as an inflating medium and employing manometers to ascertain the intra-abdominal pressure. Later we used air as an injecting medium and now we use a very simple apparatus. We have dispensed with all manometers and measuring apparatus and use merely a lumbar puncture needle, connected by suitable tubing and connectors to the pump of a Potain aspirator with a Murphy drip interposed as a trap, the small vent hole of which has been plugged. The entire apparatus except the pump is sterilized. The air is not sterilized in any way. We have found that air takes considerably longer to absorb, six to seven days, than oxygen, three to four, but it surely causes less pain; and since we practice deflation on nearly all of our patients after examination, we count the use of air a distinct advantage. We have no difficulty in determining when the needle is in the abdominal cavity by simply listening with a stethoscope on the opposite side of the abdomen for the characteristic sound of the pump.

The routine procedure which we have adopted is to wheel the patient before a vertical fluoroscope while lying on his back.

The needle is inserted, and the patient inflated under the fluoroscope. When sufficient inflation is obtained, the needle is withdrawn. He is then rolled over into the lateral position and examined on each side. After this he is put in the so-called retroperitoneal position, which I will describe later, to determine if any retroperitoneal masses are present. He is then examined in both the dorsal and ventral positions on the horizontal fluoroscope.

One case, which proved to be a retroperitoneal mass, illustrated so well the position I am about to show you for the detection of these masses, that we very soon conceived the idea of using it in many other cases.

The patient presented himself with a mass in the right lower quadrant, very hard and well defined, and of questionable origin. It caused quite a controversy among the surgeons and the genito-urinary man, as a result of which we made pneumoperitoneum examination and fortunately for us, it showed the outline of the mass very clearly, and that it was in no way connected with the kidney. In an effort to determine whether the mass was retroperitoneal, we injected the ureter and kidney pelvis. We noted the smooth outline of the ureter, and then by pressure on the mass with a cone, directing the pressure upward, and inward, were able to demonstrate a kink in the ureter. This seemed to indicate that the ureter ran over the mass, and that the mass therefore was retroperitoneal. We noted, also, the carious appearance of the third and fourth lumbar vertebrae, and suspected a tuberculous abscess. He was then put in this position—chest and thighs supported by two blocks—with his abdomen hanging loosely between; exposing from side to side, we obtained a view of the retroperitoneal and prevertebral space. The mass was retroperitoneal, and proved to be a psoas abscess. You will note that the prevertebral space, which is usually clear, is encroached upon in this way. This case demonstrated so well the advantage of this position in demonstrating retroperitoneal involvement that we began to utilize it for this purpose in other cases.

This is a diagram merely to show the arrangement of the abdominal organs in this position; the abdominal wall sagging between two blocks permits the intestines and all organs with mesenteric attachment to fall forward, showing clearly the retroperitoneal structures and clear prevertebral space. If there is a retroperitoneal mass, this mass encroaches upon this clear prevertebral space.

The first case is a mass which was not attached to the anterior abdominal wall. In this case, we rolled the patient on the side and showed that the spleen was high up under the diaphragm and entirely independent of the mass. To determine whether the mass was connected with the kidney, we injected the ureter wth thorium, and found an irregular mass in the midst of this area. The colon was injected to see if it was the origin of the mass, but it did not seem to have any connection with it. Examination in the retroperitoneal position, however, disclosed very clearly that the mass was retroperitoneal, and was closely associated with the left kidney. We have used this position successfully in determining the presence and origin of a sarcoma of the kidney; a retroperitoneal carcinoma secondary to carcinoma of the prostate, and closely associated with the kidney; a perinephritic abscess; a psoas abscess; an abscess arising in the seminal vesicle and a retroperitoneal carcinoma secondary to a carcinoma of the bladder.

I feel that with more extensive use this position will prove of great diagnostic value in determining the retroperitoneal character of masses.

Dr. Carlos Heuser, Buenos Ayres. With the dental anaesthetic apparatus of Clark, intended for oxygen gas and ether, I use a mixture in the proportion of 35% gas to 15% sulphuric ether by drops which are mixed with the gas and 55% oxygen, giving 1500 to 3000 c.c. of this mixture with my special needle. The advantages are as follows:

1. The patient can be examined standing. Deep breathing does not hurt him..
2. The mixture is absorbed rapidly.
3. The patient is not left with any pains.
4. The method can be used in the consulting room.
5. There have been observed no abnormal symptoms.
6. With the manometer attached to the instrument, it is possible to measure the quantity of gas injected, to know the pressure, and whether or not the gas mixture has penetrated into the abdominal cavity.

The needle is of platinum with a special mandrin and an escape key similar to the ordinary trocars. The purpose of the mandrin is to prevent the needle from bending when the puncture is made. The cannula with the escape key gives escape to the air after the roentgenogram has been finished. I leave the cannula in the abdomen during the making of the plates. I consider this method a great advantage and a great relief for the patient.

Dr. W. C. Alvarez. Generally we put in gas with the patient on his back. It seems to me that this gas might be trapped on one side or the other, depending on whether he rolls over to the right or to the left. Much depends, also, on whether the body is quite even on the table.

I think this type of case which Dr. Sante has just described is the type in which you must use oxygen or air or something else that will stay. It is well not to use too much; one to two litres I find is generally sufficient. Don't do this work for idle curiosity, and don't do it if there are any signs of inflammation.

Dr. A. F. Tyler. I would like to ask Dr. Alvarez if he has had any trouble in introducing carbon dioxide with the patient going into shock.

Dr. Alvarez. I have had nothing like that.[1] Most of the patients have had very little trouble. Don't let them sit up or stand up until they have had the gas in them for some time.

Dr. William H. Stewart. Dr. Rubin's work on testing the patency of the fallopian tubes by means of injecting oxygen into the uterine cavity is entirely foreign to pneumoperitoneal *x*-ray diagnosis, so much so that the speaker does not feel competent to discuss the communication although he can readily appreciate the value of such a procedure.

[1] Note: Since this meeting I have seen one case with most alarming cyanosis and stoppage of the heart, showing again that this technique should not be used thoughtlessly or needlessly.

Dr. Van Zwaluwenberg's presentation has been most enlightening, particularly so as the practical value of pneumoperitoneum in pelvic cases has long been a question in the speaker's mind. Many gynecologists will not accept the method as a routine procedure, saying that they are able, except in some very obscure cases, to make their diagnosis without pneumoperitoneum. There is every indication, however, that the method will be so simplified that it can be used in all cases where a diagnosis cannot be made by the ordinary methods.

Dr. Sante's remarks with reference to the question of gas collecting on one side of the peritoneal cavity, is debatable. Personally the speaker believes it is purely a coincidence, for unless the abdominal cavity is inflated to a considerable extent the gas is apt to collect in any one place. One of the difficulties to contend with in this work is to obtain a uniform distribution of the gas. Intestines which are distended with gas or feces will prevent this uniform distribution, and frequently form pockets in the peritoneal cavities where the inflated gas will accumulate.

. Dr. Alvarez' communication is most important and great credit should be given to him for the suggestion of the use of carbon dioxide instead of oxygen. The inflation technique which we are employing at the present time is somewhat similar to that reported last year. If a complete fluoroscopic as well as roentgenological examination is required, oxygen is the gas of selection. Should the investigations be of a single organ, such as the gallbladder, carbon dioxide is used. This gas is absorbed very rapidly, usually disappearing in about half an hour. A mixture of 2 parts of carbon dioxide to 1 of oxygen is very satisfactory where the investigations will consume about an hour.

[The speaker showed lantern slides of a series of cases in which pneumoperitoneum had proved of great value in securing a diagnosis.]

THE COLLATERAL TREATMENT OF MALIGNANT PATIENTS UNDERGOING RADIOTHERAPY*

By E. H. SKINNER, M.D.

KANSAS CITY, MISSOURI

PROBLEMS are constantly arising in the management of malignant patients who are undergoing radiotherapy. The comfort of our patients and their symptomatic care is quite another thing from the actual application of radiant energy.

There are two aspects to radiotherapy and the malignant patient. The one presupposes that the application of the radiant energy is the one essential. The patient and his disease are overlooked in an ambition to secure the proper dosage and consequent shrinkage of the tumor mass.

The viewpoint that I wish to present may be summed up in the aphorism: Beyond the cancer is the cancer patient.

If we had a panacea for malignancy in radiant energy there might be some excuse for overlooking the patient and simply treating the malignancy. Unfortunately this is not so. Therefore we shall probably achieve a more reasonable success if we observe ways and means to promote the comfort and symptomatic relief of our patients. The more one is engaged in the handling of this class of patients, the more does one realize that our therapy is far from being a specific in spite of the remarkable changes that the tissues obtain from radiant energy.

The chief difficulties with our malignant cases are poor morale, deficient appetite, irradiation sickness, distressing local symptoms and the subtle changes in the blood and internal secretions. Upon the latter, much may be conjectured, little is known; but it may not be amiss to venture certain observations, relate certain animal experiments and their possible application in radiologic practice. The former group of systemic difficulties is met in almost every case of desperate malignancy. The local symptoms necessarily vary with the type of involvement.

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*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14-17, 1920.

The subject easily divides itself into the following headings:

1. The mental attitude of the patient.
2. The general state of health of the patient.
3. The dietetic care of the patient.
4. The adjuvant therapy of local and general symptoms.
5. Amelioration of symptoms by variation of dosage.

The Mental Attitude of the Patient.—Patients come to the radiologist with great hopes of relief and possible cure. Every effort should be expended to maintain this attitude even to the extremity of prevarication, because it is noticeable that the patient loses rapidly as soon as he loses hope. This hopeful attitude is an enormous factor. The physician should, however, never fool himself or the family. There should be a perfect understanding between the radiologist and some responsible member of the family.

On the other hand if the patient comes to the radiologist reluctantly and without hope it behooves one to make every effort to raise the morale of the patient by encouraging the fighting spirit and hopeful attitude. This is hardly fair in the absolutely hopeless case. The judgment and experience of the radiologist is far more important than the potency of his irradiation in this situation. Again would I invoke the words of Shakespeare:

> . . . to thine own self be true,
> And it must follow, as night the day,
> Thou canst not then be false to any man.
> *Hamlet*, Act I, Sc. 3.

This buoyancy of hope is a greater factor than tonics in maintaining the general condition and the appetite of the patient. The cheerful attention of the physician and those in contact with the patient and the minimizing of the symptoms to the patient are worthy ideas.

The General State of Health of the Patient.—The general state of health of the patient which necessarily includes the diet should be constantly in mind, for in our efforts to eradicate malignant tissue we may be taking advantage of the reparative powers of the patient or developing gastric symptoms which will negative our local results. Every radiologist must be cognizant of the violent gastric symptoms which are coincident with radiant therapy, especially of the abdomen. There are reliable reports of metastases supposedly caused by vigorous treatment of the apparently localized malignancy. There is ample evidence from animal experimentation that radiation has the capacity of destroying the very cell factors in the blood which are at the same time the most potent agency in the actual destruction of the malignant cell. We refer to the lymphocytes of the blood. While heavy dosage will destroy the lymphocytes, small repeated doses will stimulate their development. The thought therefore arises—is it always best to attempt to overwhelm a malignancy with deep penetrating dosage, or should an attempt be made to fortify the patient by stimulating his cellular resistance to malignancy? Furthermore, may we not be hastening or actually producing metastasis by vigorous primary radiation? The idea of immunizing the patient by gradually increasing dosage may be worth consideration.

In spite of the dissensions of opinion regarding the so-called acidity or alkalinity of cancer patients, it is our humble experience that it is more comfortable to the patient to promote the alkalinity of the excretions and at the same time quiet the gastric symptoms. The milk of magnesia is a most valuable remedy, as it tempers the stormy stomach and favors colonic regularity. The drinking of waters which carry a high soda content is more agreeable than frequent dosage with soda bicarbonate. The latter is valuable to promote a rapid alkalinity when the patient is first seen and for acute attacks of gastric discomfort, but the milk of magnesia and the waters are better for long periods of time.

The Dietetic Care of the Patient.—When one seeks the literature for information upon the dietetics of malignancy one finds contradictory ideas. For many years the teachings of Bulkley have held us to the idea that alkalinity should be the goal. The experience of radiologists with deep irradiation sickness and the general relief of symptoms by soda bicarbonate seems to make us disciples of Bulkley. Now comes one worthy Joslin to the opposite opinion with an interesting array of argument:

> "There never was in the world two opinions alike, no more than two hairs or two grains; the universal quality is diversity." *Montaigne.*

> "Inconsistencies of opinion, arising from changes of circumstances are often justifiable." *Daniel Webster,* Vol. v, p. 187.

> "Thus times do shift—each thing his turn does hold;
> New things succeed, as former things grow old."—*Herrick.*

Experience and custom seem to demand that the general diet should tend toward alkalinity. Milk and the vegetables and cooked fruits and cereals are easily the basis of the daily dietary. Bulkley has outlined very specifically the intimate details of rotating variations in the daily meals. Torbett has furnished an alliteration that sticks: "Prunes, plums, peanuts; Canteloupe, cabbage, cranberries; these are foods which leave acid radicals in the blood." It is well to remember that spinach is richer in iron than any other vegetable and that the baked potato eaten with the skin furnishes a great deal of lime. Whole-wheat bread and popcorn are happy thoughts.

Dietetic experiments upon rat tumors, quoting Corson-White, reveal that a diet of vegetable protein, fat, and carbohydrates retard the growth of tumors, while the general condition of the animal seemed normal. On the contrary, high cholestral feedings seem to increase tumor growth. Hunt Reid finds that it may be well to consider diets that influence the ductless glands; oats and potassium iodide stimulate the thyroid, while eggs and milk inhibit the thyroid.

As an element which may be of increasing interest we would suggest blood transfusion for the patient who has a decided alteration in the blood picture due possibly to irradiation. This procedure may be considered where there is a low lymphocyte count or a pernicious anemia. In the former it would probably be wiser to withdraw a certain amount of blood and then donate a similar amount from a properly typed doner. In the latter case—pernicious anemia—a properly typed blood could be given without any withdrawal. It is probably best to hypothocate that the low lymphocyte count is due to irradiation and there is no decrease in the red blood cells, while in the pernicious anemia the condition is a sequela of the malignancy.

The Adjuvant Therapy of Local and General Symptoms.—Therapeutic suggestions may be grouped as general or local.

General measures are Blaud's pills, bitter tonics, potassium iodide, arsenic and strychnia, arsenical injections (salvarsen), protonuclein and glandular extracts. There is no reason why the patient should be denied the possible advantages of remedial measures of historical value simply because they are now undergoing a treatment by radiation and hope.

The use of arsenical injections and glandular extracts to enhance the value of radiation is worth consideration. We would also reiterate the values of the milk of magnesia and alkaline waters as general therapeutic measures in every case.

The local symptoms vary. With uterine malignancies we have the bladder and rectal symptoms (eminent radiologists to the contrary). With sigmoid and visceral malignancy there are few local symptoms. With mouth and throat cases, there are the distressing symptoms of ptyalism, pain, and ulceration and bleeding.

Brief local measures are suggested as follows:—Pelvic malignancy: Peroxide cleansing. Mild astringent tampons. Chloretone and icthyol tamponage. Acetone packing.

Dakinize with extreme care for the viable tissues for twenty-four hours at three days' interval.

Breast Malignancy: Potassium permanganate for ulcerations. Salt pork poultices. Screening with parafine mesh. Balsam peru. Peroxide cleansing. Aristol dressing.

Mouth Malignancy: Potassium iodide to promote mucous membrane activity and atropine in alcoholic to physiologic equilibrium for ptyalism. Potassium chlorate for mouth wash. Pack ulcerations with soda bicarbonate. Silver nitrate applications.

Pain: Start with aspirin. Add phenacetine. Turn to papine. Then codeine. Terminal refuge is morphine.

The cancer patient is entitled to relief from pain, as there is nothing to be gained by fighting the pain or bearing the pain. It is bad enough to endure an incurable malignancy, so why add the burden of pain and discomfort. Irradiation surely reduces and sometimes eliminates the pain and it surely affords an easy exitus for the desperate malignancies even if it does no more.

There is no doubt but that irradiation by *x*-ray and radium is the greatest boon that the malignant patient has had during all the ages, and it has surely come to stay as a possible cure in many conditions; at least a prolongation of life is assured, and always comfort to the patient when not a cure.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY
WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921
Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

SIXTH ANNUAL MEETING THE AMERICAN RADIUM SOCIETY
BOSTON, JUNE 6 AND 7, 1921. HEADQUARTERS, HOTEL BRUNSWICK

WASHINGTON MEETING

PRELIMINARY ANNOUNCEMENTS

Plans for the program of the Annual Meeting of the Society next fall are now well under way. Dr. Réné Ledoux-Lebard will give the Caldwell Lecture on the subject of "Deep Roentgen Therapy." It is planned to give a much larger place on the program to papers than has hitherto been done. The plan is to hold the meeting for four days, giving the entire first day to papers on therapy and to have the papers on physics during the forenoon of the second day. This will enable those who are interested only in therapy to leave about the middle of the second day, while those interested only in roentgen diagnosis would not feel it necessary to attend until the beginning of the second day. Those interested in both diagnosis and therapy would probably wish to be present the entire four days.

It is believed that this plan will make the meeting of interest to a much larger number of men. It is requested that those who have papers to present at the meeting communicate with the President of the Society at as early a date as possible.

A. C. Christie.

The Twenty-second Annual Meeting of The American Roentgen Ray Society will be held in Washington, September 27, 28, 29 and 30, 1921. Headquarters, meetings and exhibits will be at the Hotel Washington, Pennsylvania Avenue, opposite the Treasury.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of The American Roentgen Ray Society. Mr. A. Gumpert, Manager of the New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him.

The hotel rates are as follows:

Hotel Washington, every room having private bath with shower, tub and running ice water (European plan only):

	Per day
Single rooms	$5.00 to $7.00
Double rooms (double bed)	8.00
Double rooms (twin beds)	10.00 to 12.00

The New Ebbitt (European plan only):

	Per day
Single room without bath	$2.50
Single room with bath	4.00
Double room without bath, each person	$2.50
Double room with bath, each person,	3.50

Also a number of large suites, both with and without bath, which will comfortably accommodate upwards of four persons. On these suites they would make a rate of $3.00 per day each person, with bath, or $2.00 per day each person without bath.

For information regarding the program, those wishing to read papers or to show slides at the meeting should communicate direct with the President, Dr. A. C. Christie, 1621 Connecticut Avenue, N. W., Washington, D. C.

For information regarding commercial exhibits and other business matters connected with the meeting, address the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

It is hoped to arrange for special trains and cars from various sections. Details regarding this will be announced later.

THE CALDWELL LECTURE FOR 1921

THE AMERICAN ROENTGEN RAY SOCIETY is very fortunate in having secured Dr. René Ledoux-Lebard of Paris to give the Caldwell Lecture at the annual meeting this year. The distinguished standing of Dr. Ledoux-Lebard as a roentgenologist and his charming personality make it certain that the high standard already established for this lecture will be maintained.

ANNUAL MEETING WESTERN SECTION

The officers of the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY are making plans for their second annual meeting. They have selected Portland, Oregon, as the place of meeting, and the time has been set for May 27th and 28th. This time will permit of a continuous trip for the western men who desire also to attend the A. M. A. meeting in Boston.

The Pacific Coast Roentgen Ray Society will meet at the same time and place, the two organizations being the guests of the Portland Roentgen Club, a very active organization of specialists.

The Secretary of the Western Section would welcome a visitor or two from the East with papers or demonstrations, and can assure them of a very enjoyable meeting. Address Dr. Warner Watkins, Box 1328, Phoenix, Arizona.

REPORT OF MIDWINTER MEETING CENTRAL SECTION

The Second Annual Midwinter Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY was held in St. Louis, at the Hotel Statler, on February 21 and 22, with about eighty-five in attendance. The program for the two days is as follows:

Monday Morning, February 21, 1921

9:30 Opening with a Business Meeting.
  Appointment of Nominating Committee.
  DR. J. M. MARTIN, Dallas, Tex. *X-ray Treatment of Acne Vulgaris.*
  DR. D. Y. KEITH, Louisville, Ky. *Sarcoma Therapy.*
  DR. CHARLES C. GRANDY, Fort Wayne, Ind. *Fracture of the Pelvis.*
  DR. L. T. LEWALD, New York City. *Report of a Case of Hernia of the Diaphragm on the Right Side* (Confirmed by operation).
  DR. D. C. UPSON, Battle Creek, Mich. *Situs Inversus.*
  DR. H. J. ULLMANN, Chicago, Ill. *The Use of the Sphere Gap for Measuring Voltage in Roentgenotherapy.*
1:00 Lunch.
2:00 Election.
  By Invitation:
  DR. GEORGE DOCK, Professor Internal Medicine, Washington University Medical School. *X-Ray from the Viewpoint of an Internist.*
  DR. J. M. CORK. *The X-Ray Spectrum and its Relations.*
  MR. FRANK RIEBER, San Francisco, Cal. *The Importance of Accurate Standardization of Tube Potential in Therapy.*
  DR. CHARLES HUGH NEILSON, Professor Internal Medicine, St. Louis Medical School. *The Internist's Viewpoint of the Roentgenologist.*

DR. P. M. HICKEY, Detroit, Mich. *Roentgen Diagnosis of the Pancreatic Cysts.*

DR. A. W. CRANE, Kalamazoo, Mich. *Reconsideration of the Barium Meal.*

DR. E. H. SKINNER, Kansas City, Mo. *Congenital Atresia of the Esophagus.*

Executive Session for the Election of Officers.

Monday Evening, February 21, 1921

7:00 Banquet.
Lantern Slide Exhibit.

Tuesday Morning, February 22, 1921

9:30 Clinical Visit to Washington University Medical School and Barnes Hospital.

Tentative program had been arranged as follows:

(a) DR. E. L. OPIE, Professor of Pathology, Washington University Medical School. *Tuberculosis* (Demonstrations of specimens, lantern slides, etc.).

(b) DR. R. WALTER MILLS, DR. SHERWOOD MOORE. *Demonstrations in the X-Ray Department.*

12:00 Central Dry Plate Company Visit.
Buffet Luncheon (Courtesy Central Dry Plate Company).
Practical Demonstration of the Various Stages in Dry Plate Manufacture.
Visits to Local Laboratories.

The morning and afternoon sessions of the first day were occupied with reading and discussing the very interesting and scientific papers by the members and invited guests. These papers ranged in subjects over the viewpoints of the physicist, internist, diagnostician, and therapist.

Dr. Dock and Dr. Neilson, Professors of Internal Medicine in the Washington University Medical School and in the St. Louis University Medical School, respectively, brought out an important point which could be taken as a criticism in part of the roentgenologist and in part of the consultant: viz., that while there are many cases in which diagnoses can be given on one examination, there are still a large number that should have repeated examinations before the positive findings are rendered. They cited as instances, cases sent long distances because of chest findings, and major operations undertaken because of abdominal findings.

The banquet was well attended, and the pleasing music provided by the St. Louis Committee was enjoyed by all. The toastmaster, Dr. Skinner, won the hearts and applause of all when he announced that owing to the lateness of the hour and the previous entertainment, speeches would be dispensed with.

The lantern slide exhibit, following the banquet, lived up to its usual reputation, and was the most fascinating part of the meeting. Dr. R. Walter Mills presented a series of interesting stomach slides with tables showing his classification of the different types of the human form, each type having its characteristic stomach picture. Many other members exhibited a variety of slides, and much good-natured rivalry was brought out in trying to show some condition or anomaly not previously seen by one of our visitors.

The midnight sessions were held as usual in the various rooms.

On the morning of the second day the members were driven to the wonderful University Medical School and Barnes Hospital, where Dr. Opie, Professor of Pathology, lectured on tuberculosis, using lantern slides for demonstration.

A splendid buffet luncheon was served to the Society at the Central Dry Plate Company, after which the plant was inspected and the methods of plate-making were seen. It was necessary to traverse the dimly lighted parts of the factory in chain-gang fashion, as the ordinary dark-room is lighter and more easily negotiated.

A vote of thanks was given to the St. Louis Committee for their splendid arrangements and entertainment.

Dr. J. G. Van Zwaluwenberg presided.

Dr. A. F. Tyler, the Secretary, was unable to be present; Dr. William M. Doughty was appointed Temporary Secretary.

The Local Committee consisted of Dr. Edwin C. Ernst, Chairman, and Drs. E. H. Kessler, Fred B. Hall, M. B. Titterington, and L. R. Sante.

The following officers were elected for the next year:

President
Dr. William M. Doughty, Cincinnati, Ohio
First Vice-President
Dr. D. Y. Keith, Louisville, Kentucky
Second Vice-President
Dr. E. S. Blaine, Chicago, Illinois
Secretary-Treasurer
Dr. A. F. Tyler, Omaha, Nebraska

The next meeting will be held in Chicago, the date to be decided later.

ADDENDUM

Dr. Alfred S. Doyle makes the following addition to his article on page 73 of the February issue:

In the American Atlas of Stereoroentgenology, Vol. II, Dr. H. M. Imboden of New York reports a case injured in October, 1916, which was operated upon October 11th, for depressed fracture. Roentgen examination made November 8th shows an area of diminished density in the upper portion of the cranium which he believed at that time was air in the cranial cavity. On December 7th of the same year another roentgen examination was made and shows the air completely displaced by brain tissue; this patient is reported as having made a complete recovery without operation for the air.

DOSAGE MEASUREMENT

A Criticism

By J. S. SHEARER

CORNELL UNIVERSITY, ITHACA, N. Y.

Some years ago the writer of this article published a paper on the photographic effect of x-rays when variations of current and voltage were made and *no* filtering material except the walls of the tube and the usual paper envelopes were between the target and the sensitive emulsion. The results showed that for a *given* wave form the time required to secure identical blackening of spots on the same plate could be quite accurately computed by assuming that:

1. The time was inversely proportional to the current when voltage and distance were unchanged.

2. The time was inversely proportional to the *square* of the *effective voltage* when current and distance remained fixed.

3. The time was directly proportional to the square of the target plate distance for current and voltage unchanged.

Thus for unfiltered rays the photographic effect was indicated by the relation

$$\frac{\text{current} \times (\text{voltage})^2 \times \text{time}}{(\text{Target} - \text{plate distance})^2}$$

Also the reasonably accurate reproduction of results with different machines, as indicated by photographic action when reasonable care was taken, suggested the use of these measurements *in the place of Kienböck strips or pastilles*. This was advocated because observation of the work of many students showed there was better agreement in results than when the prevailing methods were employed. Measurements by ionization methods have indicated the above formulation to be substantially correct within the range of voltages in common use and where wave forms do not vary too much. Also, since in this same range "spark gaps" are nearly proportional to voltages, gap measurements may be substituted for voltage. The use of this method has become fairly general in this country, and we now see statements of current, gap, filter, distance and time as a rule instead of so many H or X units.

The general principles of physical measurements are sometimes rather complex and are often not well understood. This is always true when methods are developed and units adopted before facts can be fully investigated, also methods are frequently applied in ranges outside their proper limitations.

As an example, assume that we wish to use a photographic method to measure light. Let portions of a plate receive exposures for 1, 2, 3, 4, etc., units of time to radiation from a constant source. No one would question that here exposures would be in proportion to the times. If we lay off along a horizontal axis a series of equal steps as 0-1, 1-2, 2-3, etc. (Fig. 1), we may erect perpendiculars at these points whose lengths correspond to the measured density of the negative where these exposures acted. Suppose one made measurements between A and D, and observed that here density increased very nearly in proportion to exposure. A unit for exposures might be chosen as U, and we say that A received 4 units, B, 5 units, C, 6 units. Any other area having a density *equal* to that at A would also be said to have received 4 radiation units. If now we attempt to use the density of the negative as a measure of exposure below A, or above D, we have trouble, since a small exposure may cause *no* measurable density. Neither can we infer from the density K what exposure the corresponding spot received. For had the relation between exposure and the density produced not changed, then this particular density would have been attained by a shorter exposure. Thus no determination of exposures below or above certain limits are possible: below there is little or no density, while above the density changes but slightly even with great increase in exposure.

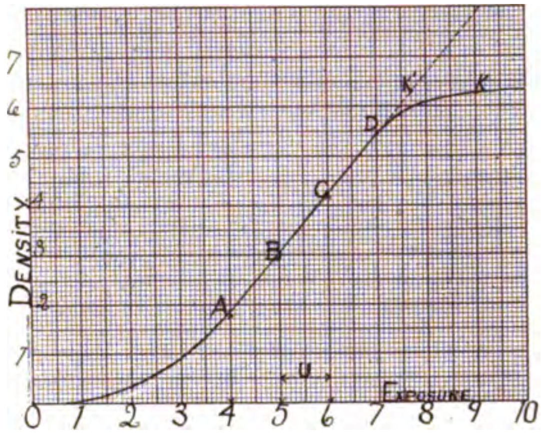

FIG. 1. VERTICAL LINES SHOW DENSITIES CORRESPONDING TO EXPOSURES SHOWN AT BASE. Thus A4 is 1.9 in length, B5 is 3 units, or 4 arbitrary exposure units gave 1.9 units of density.

The same applies to a pastille, too little exposure will not cause a perceptible color change, and after a certain yellow brown tint is reached no further change in tint is observed. Also if an exposure *exceeding* certain limits is made there is no way of determining *how much excess radiation has been received.* Pastilles were introduced when induction coils and gas tubes were in general use and there were wide differences in outfits. The fact that their maximum change in tint was so nearly attained by exposure to a quantity of radiation that could safely be delivered to the skin made them exceedingly valuable for skin therapy at that time. But in the use of fractional doses, heavy filtered doses, and when we consider the difficulties of keeping and reading pastilles we recognize the need of some other measure.

We sometimes say that one quantity "runs parallel" with another, meaning they increase or decrease together in a fixed ratio. Thus on the straight line portion of Figure 1, exposure and density "run parallel" over a considerable range, but not over all ranges. The biological action of many, perhaps of all stimuli, varies with the dose according to a law similar to that "of decreasing returns" in economics, or by an approximately logarithmic or exponential law. Thus Figure 2

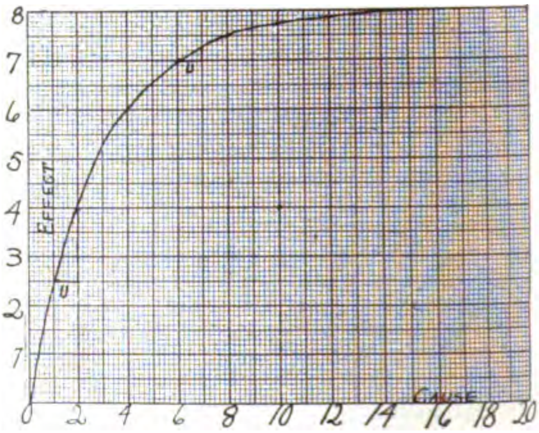

FIG. 2. A COMMON RELATION OBSERVED BETWEEN CAUSE AND EFFECT. The second unit of cause gave 1½ effect units. The 7th only .3 of a unit.

shows such a curve. To assert that each unit of the acting agent produces the same effect would be absurd, as successively applied units of causation give entirely different additions to the effect. And yet that is just what is so often done in the use of "pastilles," Kienböck's, etc., in therapy.

The therapist *need* not be concerned with such units at all. What he needs to know is *how to operate his tube to secure* the most favorable curative result with the least risk; viz., what current, voltage distance, filter, time, areas of entry, and intervals between treatments are most likely to secure a good therapeutic effect with a minimum risk of skin lesion. Also under what conditions may this dose be exceeded and by how much, when the net result may be favorable to the patient, even though temporary injury to the skin ensues.

Such a specification of dosage may seem not to involve any consideration of the laws of physics. But *this is not the case* and especially so when one considers questions of deep therapy, of filters, of proposed variations in apparatus and countless other phases of the development of therapy in which we are bound to be guided by our concepts of physics. The well established laws of radiation need no defence, neither do their careful consideration in the matters at hand require any apology.

It seems to the writer quite unfortunate at this time, when we are shortly to be able to clear up many of the disputed points in therapy, to have several articles in this and other journals giving quite erroneous interpretations of observations. The first article by Remer and Witherbee in June, 1917, questioned the voltage law as measured by pastilles. There was no reason to assume that photographic densities and color changes would run parallel to each other or either of them to skin effects over any considerable range. And no claim had been made that such was the case.

In this same article the inverse square law was questioned when filters were used. While the writer dislikes to appear controversial, references to his work have been made in several of these articles, and he has recently received letters from many sources asking if the published results are in accord with his experiments. This seems to make a public answer unavoidable, especially as the writers of some of these letters say they had unfortunate results when believing they followed Witherbee and Remer's formulation.

As in many other cases many of the *observations* of these authors are of value even though their *explanations* may be wrong, but explanations based on incorrect ideas almost invariably lead, sooner or later, to absurd or dangerous procedures. In some cases they result in the development of improper or useless appliances, in others in serious injury to patients, and they always tend to bring the work into disrepute.

When writers challenge the validity of well established physical laws they must expect a critical scrutiny of their contentions. So in the present case we may consider various statements of these authors as to their concordance and probability. In all of Witherbee and Remer's work full reliance is placed on their pastille readings or on color changes on the skin. As regards the latter one might secure a fairly pronounced erythema that would hardly be deepened in color by a considerable increase of exposure. There may also be quite a difference in biological effects at greater depths for the same apparent erythema. As regards the comparison of erythemas and coloration of the skin it would be well to remember that preconceived notions may unconsciously greatly influence readings in color matching. It is certainly questionable whether an ordinary photograph of the patient's skin is a reliable indication of the effect of radiation.

Taking now the article by these authors in the *N. Y. Medical Journal*, June 26, 1920. We may note reference to the work of 1917, where it was first asserted that the inverse square law was in error for filtered rays. All factors except distance remaining the same it is stated that at half distance one gets only twice instead of four times the dose. Or if one gets, say, 4 units at 10 inches one would get 2 at 20 inches instead of only 1.

Such a result is contradictory to all physical experience with radiant sources as small as we have in the *x*-ray tube where the variation of distance from various points of the source to an external point is too slight to consider. The claim is also self-contradictory since any given filter absorbs a definite *fraction* of the radiation it receives quite independent of the intensity. Placed close to the source more is received and more absorbed, further away less is received and correspondingly less is absorbed, but always the same fraction of that received.

Now the authors admit the inverse square law is all right for unfiltered rays.

Suppose a filter, F, (Fig. 3), is placed at 5 inches from T and the radiation is received on an areas S just beyond F. Let F receive 8 arbitrary units of radiation per sq. cm. and be of such a thickness as to absorb 50 per cent of this amount, then a sq. cm. perpendicular to the rays just beyond F would receive 4 units. According to Witherbee and Remer a sq. cm. of surface S, at 10 inches would receive two units instead of only one as predicted by the inverse square law. Now move the filter twice as far away to F; at 10 inches it is admitted that the filter would *receive* only one fourth of what it did at 5 inches, or only 2 units.

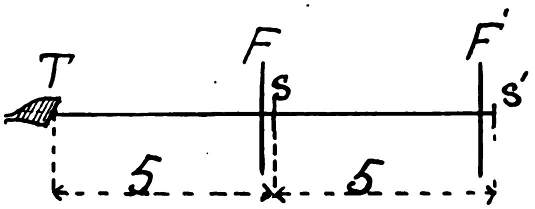

Fig. 3. F just in front of S receives 8 units of radiation, it filters out ½ or transmits 4 units. This gives only one unit on an area S′ equal to S but twice as far away. Remer and Witherbee say it gives 2 units. Transfer F to F′, they admit that if not filtered the intensity at F′ (no filter at F) would be only 2 units and it removes 50% and we get only 1 unit on S′.

Receiving only 2 units and absorbing 50 per cent of what it received, it would transmit only *one unit*. So it would follow if the physical law is not obeyed it would make a great difference where we placed the filter, while in fact it makes no difference.

It is interesting to observe that their claim as to the effect of distance is exactly comparable to their observation on change of voltage, i.e., if the V^2 law is true we would have four times as much rediation for a doubled voltage. They say only twice as much. Halving the distance gives four times as much radiation on the same area, but these authors say they read only twice as much. Does it not seem strange they should get this *exact* discrepancy in two different cases and, granting as good readings as possible, would not one be justified in doubting the method?

Next in this article we read that dosage is not in proportion to time. Using 3 mm. of al. and all remaining conditions the same:

2 min. gives 1 H
2 × 2 min. gives 1½ H
3 × 2 min. gives 2 H

Summarizing, if at a voltage V, distance D, and time T, we get a dose H:

		Physical laws predict:	Witherbee & Remer assert:
At	½D	4H	2H
At	2V	4H	2H
At	3T	3H	2H

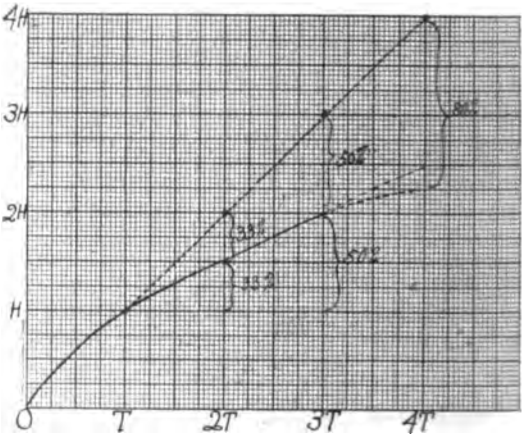

Fig. 4. Increase in Dose Indication with Equal Increments of Time. Dotted straight line shows how an indicator ought to behave. Full line shows Remer and Witherbee readings. Exterpolated beyond by dotted lines. Uncertain just how it would read at 4T.

This failure of the pastilles to read in proportion to *time* according to the observations reported is significant. In Figure 4 the straight line shows the increase of dose with increase of time, all other factors unchanged.

T = time for 1 skin unit. But their reading at 2T must be increased by one third of itself to come to 2H, the reading at 3T must be increased by 50 per cent of itself to give 3H, and extending the curve, in the absence of readings, to 4T, indicates that the *reading* at 4T would have to be increased about 80 per cent to satisfy the law of constant increase with time. Hence if under one set of circumstances the pastille is so much too low that one must add 80 per cent to 2H to get a rational measure, just why not add, say, 100 per cent to the 2H reading in the voltage and in the distance experiments?

The law of *uniform increase of dose with time* for all other conditions constant has always been used to determine the fractional scales for both the Kienböck and pastille methods. After a reading of 2H was attained we were told to *double* the *time* for 4H. Thus the scales used by these authors were fixed by using the laws whose validity they deny.

There should be a careful distinction between applied dose and the effect produced by the application. Thus if 5H is the *dose* received by a pastille it shows a marked change in color, if an additionad *dose* of 5H is then applied but little further color change is shown. The dose is a physical entity, its effect is dependent on the variable state of the receiving substance. Also if a tendency to recover is present we have another factor involved. Thus with very weak radiation in moist air and diffuse light one may have the rate of recovery of a pastille just balance the action of the radiation, yet one would hardly claim no dose.

In this same article we read as follows:

"Recently the pastille readings were taken using ¼, ½, 1, 2, 3, 4, 5, 6, and 7 mm. of aluminum, respectively. Throughout these experiments, instead of the half distance pastille registering *twice* the amount of that at full distance we find that when the half distance pastille reaches *one* and *a half* skin units the full distance pastille reads *one skin* unit and when the half distance pastille reaches two skin units the full distance reads one and a quarter. The only exception to this is when 5, 6 and 7 mm. of aluminum are used. These register half the dose of full distance and formula. This agrees with the biological results."

It is rather strange that *only after 5 mm. are used do we get agreement with biological results.*

In their previous work they declared a ratio of 1 to 2 for 3 mm. of aluminum at full and half distance. The physical law asserts the ratio is always 1 to 4.

Remer and Witherbee read 1 to 1.5 at first, then 1¼ to 2, or 1 to 1.6 up to 4 mm. of aluminum, then at once 1 to 2. So we see that the pastilles are not consistent with themselves as the *ratio* of readings is variable when two are treated alike for comparison.

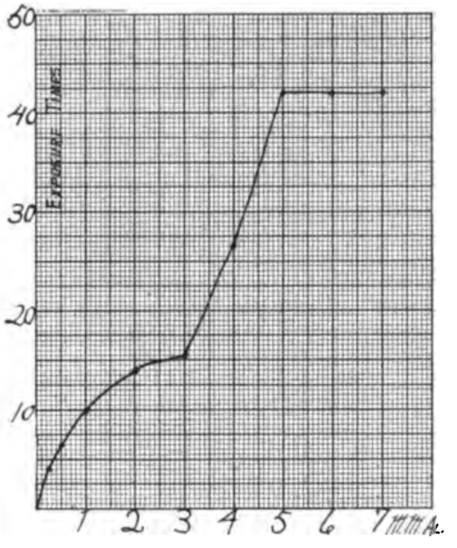

FIG. 5. EXPOSURE TIMES FOR 1H, CURRENT, DISTANCE AND GAP CONSTANT BUT USING DIFFERENT THICKNESSES OF ALUMINUM. Such an irregular line is *highly* improbable.

One way in which we may see whether results are fairly reasonable or not is to plot curves between two related quantities. Plotting from the data given, time for one skin unit at constant gap, current and distance against thickness of aluminum used as a filter we have Figure 5. Such results are quite impossible unless *all* experiments done heretofore are wrong. Why such a break at 3 mm. and such a jump between 4 and 5? And surely no one knowing anything of the effect of thickness can believe that 7 mm. and upwards would transmit the same amount of radiation as 5 mm.

Again we read:

"The principle involved in this experiment apparently changes the classical law of light, namely, the amount of light varies from the source according to the inverse square of the distance. Filtered *x*-ray produces double the amount of half distance instead of four times.

"We understand that these results in no way conform to any existing law of physics. We have been unable thus far to explain the cause of the above phenomena and simply wish to report our findings."

The authors further remark: "We do not see the necessity of using more than five mm. of aluminum as a maximum without the addition of a piece of glass, leather, or wool." Why add glass, leather or wool? Because of some property not recognizable by physical experiment? Or because some have used these as filters? At the end of the reprint we are told their "results explain the practicability of filtered ray for producing the maximum effect on the parts beneath the skin when compared with unfiltered dosage." A fact fully explained without any need of the denial of the laws of radiation. The whole result of these arguments is, if anything, to discredit entirely such methods of measurement.

In the *Medical Record,* July 31, 1920, we have another article entitled "The Cause of *X*-Ray Burns."

There appears in this article so much that is fallacious that it constitutes a serious menace to rational therapy. Omitting the figures that purport to show equality of dosage by ordinary photography of the skin the main portions of the article may be quoted. The paragraphs are numbered solely for easy reference.

1. "During the early days of roentgenology, when the gas *x*-ray tube was all there was, we were especially warned against the use of any factors with very low voltages, for the reason that low voltages produce an immense number of rays of low penetration which are absorbed by the skin and hence more liable to cause an *x*-ray burn than the high voltages whose rays are of high penetration and not absorbed by the skin.

2. "The above theory has been handed down from year to year and it is only within the last few years that the fallacy of it has been realized.

3. "Soon after the announcement of Saboraud and Noire method of treatment of ringworm of the scalp, many attempted to carry out the procedure with an *x*-ray coil instead of a static machine as used by the originators. This resulted in overdosage and permanent baldness in many of the cases. The reason for this was the failure of the operator of the coil to maintain a constant high voltage for any length of time as compared with the tube maintained by the static machine.

4. "This drop in voltage in the gas tube no doubt increases the number of low penetrating rays, and it was naturally concluded from the theory of absorption that they were the cause of permanent alopecia or *x*-ray burn. In order to test out this theory, the following experiment was made with a Coolidge Tube and reported in the June issue of 1917 of the *American Journal of Roentgenology.*

5. "Four areas of a patient's back were treated with the following factors for each area:

MA Sp. G. T

No. 1. $\frac{3\times3\times5}{8D\times8D} = 1\frac{1}{4}$ skin units $= 5H$;

No. 2. $\frac{3\times6\times2\frac{1}{2}}{8\times8} = 1\frac{1}{4}$ skin units $= 5H$;

No. 3. $\frac{3\times4\frac{1}{2}\times3\frac{1}{3}}{8\times8} = 1\frac{1}{4}$ skin units $= 5H$;

No. 4. $\frac{3\times9\times1\frac{2}{3}}{8\times8} = 1\frac{1}{4}$ skin units $= 5H$.

6. "The photograph of the patient taken

ten days after treatment demonstrates that all areas coincide, yet in two of them, namely No. 2 and No. 4, the spark gap was doubled and one-half the time taken for exposure that was given in No. 1 and No. 3, respectively. It therefore follows that if the spark gap is doubled and the time reduced one-half, the same degree of erythema will be produced, other factors remaining constant.

7. "From the standpoint of quality of *x*-ray in the above experiment, the formula with 6-in. and 9-in. spark gaps (No. 2 and No. 4) should give a very large percentage of penetrating rays as compared with the 3-in. and 4½-in. (No. 1 and No. 3), and hence one would expect that these penetrating rays derived from the higher spark gaps, 6 and 9 (No. 2 and 4) would pass through the skin and take much longer to produce the same degree of erythema as that followed by the use of 3 and 4½-in. formulae (No. 1 and No. 3). Exactly the reverse proves true. For it took just one-half the time for the same biological effect in the doubled spark gaps (No. 2 and No. 4) as it did in the 3 and 4½-in. (No. 1 and No. 3) formulae.

8. "It is, therefore, apparent that the quality of the ray and the absorption of those of long wave length have little to do with the biological effects in the skin. On the other hand, it seems that the factor which determines this effect is solely the quantity of *x*-ray reaching the skin, for it is obvious that a high spark gap produces more rays that reach the skin than the same dose with a low spark gap.

9. "Recently we have tried out the following factors on the skin of a patient's back:

MA Sp. G. T

$$\frac{5\times9\times9/1.6\text{ min.}}{6\times6\text{ D}}=$$

33¾ sec. = 1¼ skin unit = 5H.

10. "This is an erythema dose without a filter. The filtered erythema dose using 3 mm. of aluminum is as follows:

MA Sp. G. T

$$\frac{5\times9\times7{\cdot}7\text{ min.}}{6\text{ D}}=$$

2½ skin units = 10H.

11. In the photograph both areas of erythema are identical. No. 1 was produced by the unfiltered erythema dose; No. 2 by the filtered erythema dose. Biologically, to all appearances, the erythema produced in 33¾ seconds by the unfiltered ray is the same as that produced in 7 minutes and 42 seconds by the filtered.

12. "If the voltage determines the quality of the ray, then in this experiment the voltage is the same in both instances; the only difference is the interposition of 3 mm. of aluminum and about ten times longer exposure for the filtered dose as the unfiltered. Here again the quantity of *x*-ray reaching the skin is materially lessened by the aluminum, thus making the enormous difference in the time of exposure.

13. "This dose with 3 mm. of aluminum takes a little over ten times as long to produce an erythema as it does without aluminum. In speaking of this dose some writers would say that they gave ten erythema doses. This statement without qualification is misleading. In reality the effects, so far as the skin reaction is concerned, are identical. If then the filtered and unfiltered erythemas are the same, the only difference being in the number of rays reaching the skin, thus increasing the time, why is it that a filtered dose is five or ten or any other number of erythema doses? The fact remains that *biologically filtered and unfiltered erythemas* are *identical,* as exemplified in Experiment No. 2, illustrated in Fig. 2; that 1¼ skin units unfiltered = 5 H or one erythema dose, also that 2½ skin units filtered or one filtered erythema dose.

14. "By increasing the thickness of the filter and decreasing the spark gap the time necessary for a filtered erythema dose, namely 2½ skin units can be progressively increased. *Although decreasing the spark gap in unfiltered dosage lengthens the time of exposure for an erythema dose,* the time ratio between the lower voltages and the thickness of the filter is many times greater than those of the higher voltages. Therefore, one might select a formula with a very low voltage and be able to say that one gave forty or fifty erythema doses.

15. "If then, in describing the *technique of filtered dosage* we adopt 2½ skin units as the standard for an erythema dose, we can use it with the same degree of accuracy as we have the erythema dose of unfiltered dosage."

Among the lessons learned by the early

roentgenologists at the price of bitter experience the one that stands without modification to-day is stated in paragraph 1. The "fallacy" is solely in the proposed explanation by these authors.

When the voltage at which a tube is operated is *reduced, rays of all kinds* (i.e., of all wave lengths) *emitted by the tube are decreased* in intensity, none whatever are increased, many are reduced to nothing. The static machine gives a larger percentage of *short* wave lengths than a coil operated at the *same spark gap.* It may also be remarked that if one operates a coil with inverse through the tube the milliampere reading will be the difference between direct and inverse so that one might even have the meter read zero and yet operate the tube. In such a case we surely would have excess dosage. But now the authors introduce experiment and then interpretation as in paragraph 7. There is here exhibited a common confusion of mind in the use of the term *quality of x-ray.* If a tube operated at a 4½ in. gap, emitted only one (ray?) i. e., one wave length, l_1, and at a 9 in. gap it ceased the emission of l_1, and substituted a new, more penetrating ray of wave length l_2, and if these carried the same energy the "much longer" contention claimed as a prediction from the theory would be well founded. But the facts are entirely otherwise, and the so-called "reverse" only shows a misconception of well founded laws. There are rays at a 9 in. gap more penetrating than *any* at a 4½ inch, also *all those present at a 4½ inch gap are present in increased intensity at a 9 inch gap.*

On account of the smaller percentage absorption of the rays of higher penetration that are *added* when the operating voltage is raised one should not expect that the time for erythema would be reduced to one-fourth by doubling the gap but the writer believes that it is reduced much more than stated in the article quoted.

Paragraph 8 is the most dangerous misstatement relating to *x*-ray therapy that the writer has read in a long time. To say that the absorption of waves of long length has *little* to do with biological effects is to contradict all experience. Again experiment and explanation. Two doses, equal according to the belief of the authors were given to a back and a photograph taken. Suppose they had given 8 min. or 9 min. with filter and 25 sec. or 40 sec. instead of 33¾ without filter, would the photographs have been different? In other words how accurately does equality of negative density or even the unaided eye as a measure of erythema indicate dosage? And if accurate enough for skin therapy are they good guides for deep therapy? Also the writer sincerely hopes no one will use a *9 in.* gap and a *6 in.* target skin distance.

In 12 we again see lack of perception of the real facts. It is true that the quality of the beam *before* filtration was the same in the two cases, also the filter did reduce the quantity of all wave lengths reaching the skin, but the reduction is enormously greater in the long wave lengths so the quality of the radiation *reaching the skin in the two cases was very different.* The only remark which we might agree with is the objection to describing dose by the number of X or H units or multiples of erythema doses.

Now it is true that the same skin effect may result from the absorbtion of equal quantities of radiation irrespective of the actual wave lengths, but the effect is never confined to the skin alone. Thus, glands are often affected to a greater extent than is indicated by the skin reaction. The patient, not simply the patient's skin, is treated.

The article in this JOURNAL (October, 1920, pp. 485-492) contains the same errors as those already cited, in fact in the main it is a rearranged reprint of the others; note the second column of page 488 and the difficult expression as to gaps on page 489.

Whether or not doses of filtered radiation such as described by these authors are both useful and safe must be left to the experience of those who use them. But to base dosage on a method that is so much at variance with well established physical laws, and giving readings inconsistent among themselves, requiring such a vast amount of useless arithmetic can only lead to confusion.

Why cumber our literature with all sorts of units such as H, skin units, ½ H, Hampson units, X units, etc. No one conversant with any of these units can fail to realize the difficulties in their use. While transformers and high tension rectifiers are not perfectly comparable one with another, yet if the rectifier is properly set and the milliammeter is reasonably correct, dosage can be quite accurately reproduced.

If experience shows that a patient having a given disease is most benefited on the average by using a certain current, sp. gap, distance, exposed area, filter and time, that *specifies how to attain* the desirable dose. If the first four are constant the gap being selected properly and reasonable current and distance used, let us assume that half this dose is given when the time is halved. Then when quarter or other fractional doses are prescribed there is only one factor to divide and we have no cumbersome formulae giving a fictitious appearance of accuracy.

Finally it will probably be found that discrepancies between physical laws and amounts and quality of radiation as estimated by color changes, etc., are due either to incorrect exposition or understanding of physics or to defects or limitations in the methods of measurement. In fact the writer ventures to predict that rational radiation therapy will finally be based on the physical laws of radiation. The application of such radiation will ultimately be perfected by reference to the cumulative experience of those who apply these laws properly.

Only when dosage measurements are expressed in a common language, using terms capable of exact meaning can we hope to have the present chaotic condition clarified so as to realize at once the ultimate value and the equally important limitations of this therapeutic agent.

Again I wish to call attention to the reason for this criticism. I am questioning neither the therapy nor the care or skill in reading pastilles of the authors. Whether one should use filtered or unfiltered radiation, 6 or 12 inch spark gap, one minute or one hour, is not for me to say and I surely would not discuss such matters in print. But what therapists will do with radiation depends very much on their conception of the physical side. The extension to higher or lower voltages and choice of filters ought to be based on correct use of the physics involved, to the end that therapists may secure reproduction of results, or, failing that, may be sure that the differences are due to the patient and not to the radiation utilized.

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TRANSLATIONS & ABSTRACTS

Kingery, Lyle B., Ann Arbor, Mich. Saturation in Roentgen Therapy—Its Estimation and Maintenance. (*Archives of Dermatology and Syhilology,* April, 1920.)

Two widely separated methods of administrating radiation with x-rays have been in use since the discovery of roentgen rays; the older method by which the maximum effects are gradually obtained by the administration of small doses, repeated at short intervals, and continued over a long period of time ("fractional dosage"), and differing radically, the more recent method of "massive dosage," by which the maximum effect is obtained at once. It is to be seen, as the writer points out, that in each method the maximum effect is either preceded or followed by a stage during which the tissue effects are not definitely shown. In the older method this occurs during the period before cumulative effects result in erythema. In the method of massive doses, a period of indefinite influence follows the original maximum effect.

Each cell which has absorbed roentgen rays undergoes a biochemical change, which may produce on appreciable effect, or may result in stimulation, inhibition or erythema, according to the quantity of radiation absorbed. Presumably this sequence of stimulation, inhibition and destruction always occurs; it may precede the erythema resulting from repeated small exposures, or it may follow in the reverse order, the erythema consequent to a single large exposure. In other words, the effect produced will vary according to the amount of rays absorbed by the cell, and one aspect of our problem becomes the maintenance of the optimum quantity in the cell.

This depends upon the rate at which the effects of the rays are lost. Depending on this rate is the frequency with which exposures may be repeated, and the quantity that may be administered at each exposure. The author assumes that tissues exposed to x-rays lose that effect in a constant manner. The greater the concentration of the biochemical products of irradiation, the higher the velocity of loss is borne out by certain observations. If this be true, and if we may assume that the rate of loss varies directly as the concentration of some hypothetical decomposition product, then as this concentration decreases, the velocity of loss will become less in the same ratio. Thus, at such time as this concentration has decreased by one half, the corresponding time rate of loss shall have become less by a corresponding amount, and so on, until the residual effect has become negligible. This rate of loss, theoretically, would represent a logarithmic curve and may be so calculated. Such a curve has been established for many chemical and biologic reactions, which we know as "mass reactions," and if we may be permitted to draw an analogy, the biochemical change resulting from the absorption of roentgen rays by tissue elements may follow a similar law.

Proceeding upon the basis of the above hypothesis, that the decreasing residual effects of roentgen rays follow a logarithmic curve, a series of experiments were undertaken by Kingery. He found that a full dose could be repeated after an interval of fourteen days without producing unfavorable complications. Trying, then, the interval at which 75 per cent and 50 per cent could be given, he found it to be seven and three and a half days respectively, that is, at the end of seven days, 75 per cent of the original dose could be given without unfavorable reaction, and at the end of three and a half days, 50 per cent of the original dose could be given. From these intervals, a curve was constructed showing the intervals at which a condition of "saturation" diminished until there is little effect remaining in the tissues. By consulting this chart or curve, it is possible at the end of four, five, six days, or at the end of any interval less than two weeks, to determine the percentage of the original dose given to bring the tissues irradiated back to the same point of saturation previously administered.

In conclusion Kingery enumerates the advantages of this method:

1. Accuracy with which desired irradiation effects may be obtained and continued.
2. Avoidance of stages of incomplete saturation, perhaps of questionable influence, by properly measured doses at proper intervals.
3. Ability to duplicate accurately effects after various time intervals, even by different operators.
4. Constant protection of patients from the results of improper time and dose relations.

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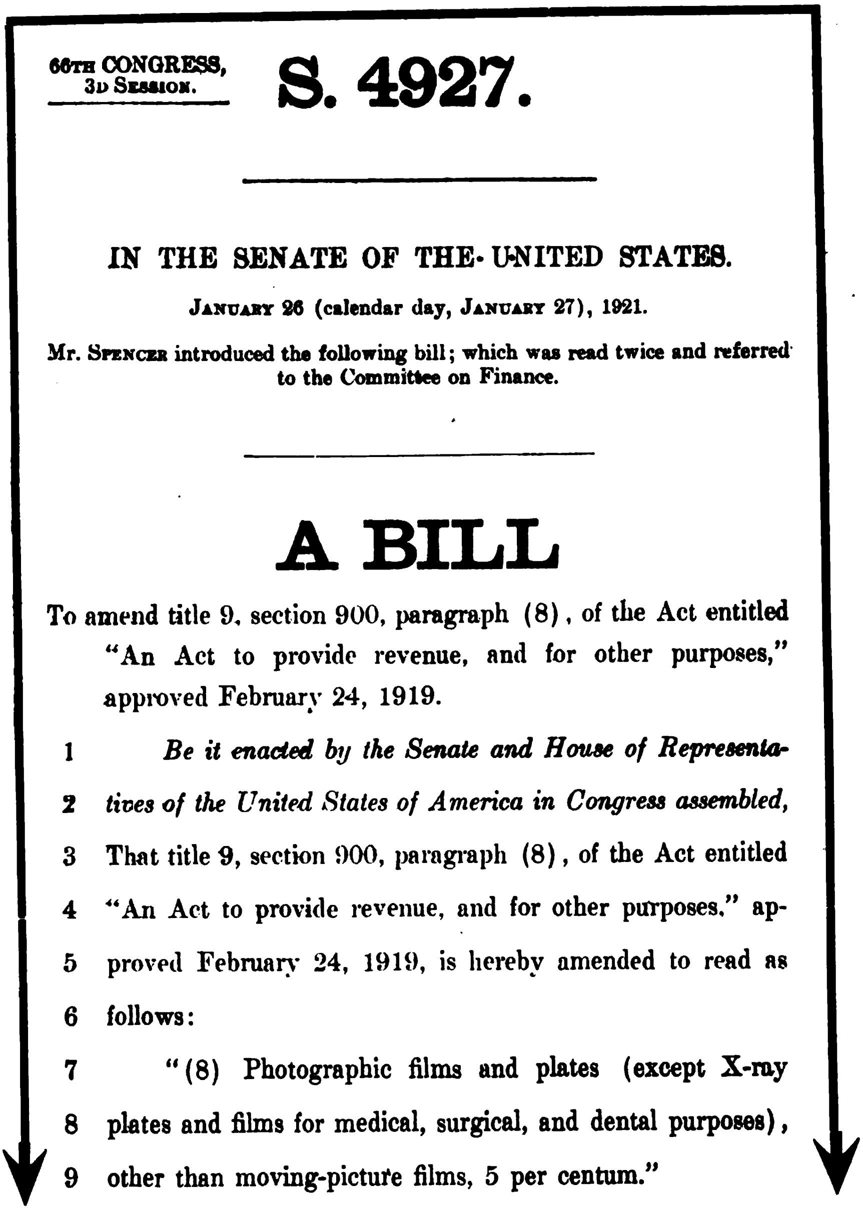

66th CONGRESS,
3d Session.

S. 4927.

IN THE SENATE OF THE UNITED STATES.

January 26 (calendar day, January 27), 1921.

Mr. Spencer introduced the following bill; which was read twice and referred to the Committee on Finance.

A BILL

To amend title 9, section 900, paragraph (8), of the Act entitled "An Act to provide revenue, and for other purposes," approved February 24, 1919.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title 9, section 900, paragraph (8), of the Act entitled "An Act to provide revenue, and for other purposes," approved February 24, 1919, is hereby amended to read as follows:

"(8) Photographic films and plates (except X-ray plates and films for medical, surgical, and dental purposes), other than moving-picture films, 5 per centum."

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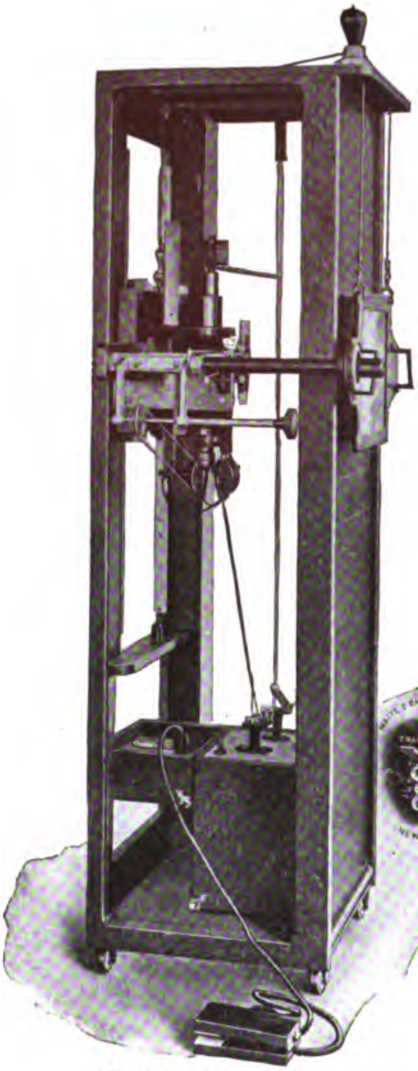

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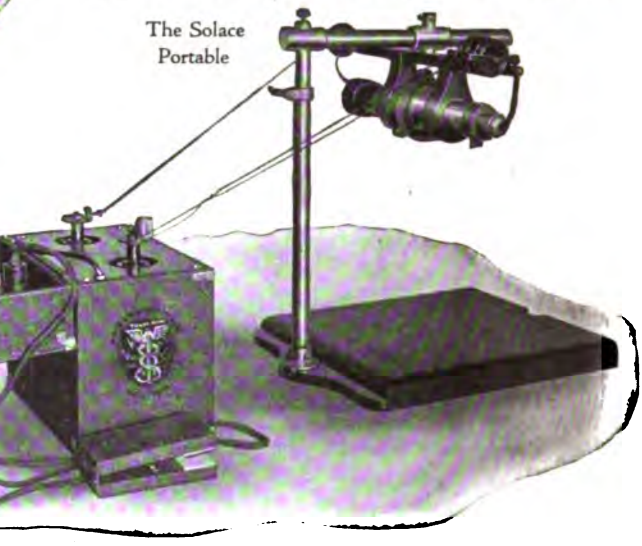

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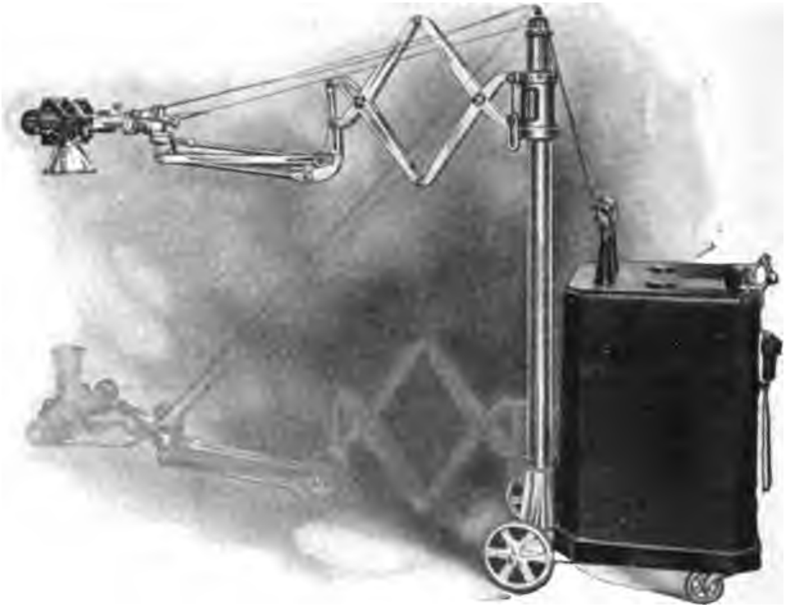

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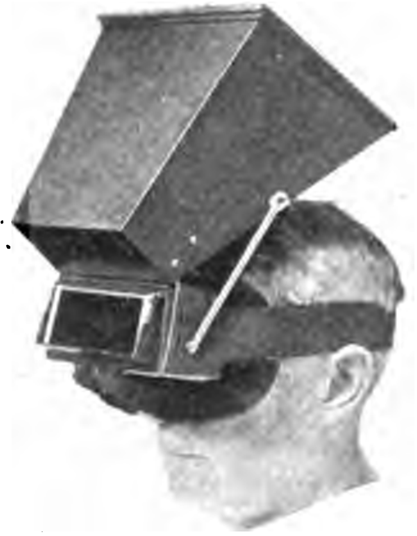

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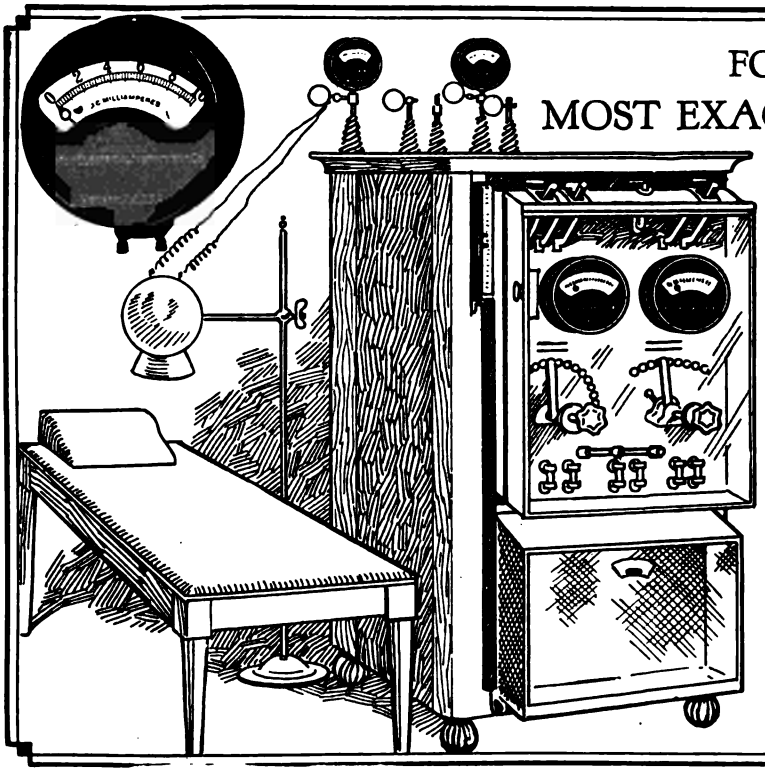

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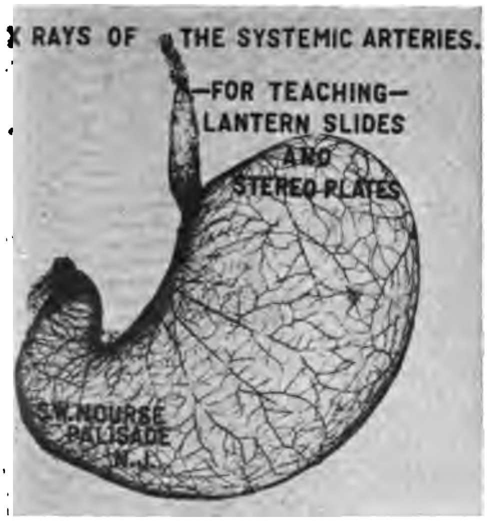

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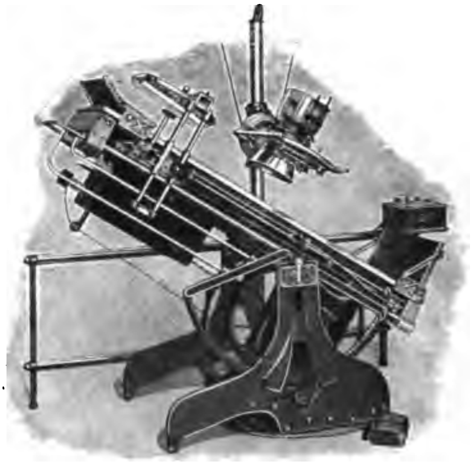

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VOL. VIII (NEW SERIES) APRIL, 1921 No. 4

THE INTRALARYNGEAL APPLICATION OF RADIRM FOR CHRONIC PAPILLOMATA*

By PRESTON M. HICKEY, M.D., F.A.C.P., F.A.C.S.

DETROIT, MICHIGAN

THE purpose of this paper is to describe the treatment of intractable papillomata of the larynx with radium. The patient on whom this was used is now thirty-eight years of age. Ten years ago she noticed that her voice showed signs of huskiness; soon a complete aphonia developed. She was treated by her family physician and a local laryngologist for a period of two years; at the time I first saw her, she had had a loss of voice for over two years.

Laryngological examination showed that the lumen of the larynx was occluded with papillomatous masses. These partially covered the epiglottis and the false vocal cords. An attempt was made to remove the neoplasm with forceps introduced through the Jackson laryngoscope. On account of the difficulty in hyperextension of the neck, owing probably to shortness of the cervical ligaments, it was found impossible to operate satisfactorily with the direct laryngoscope. Repeated attempts were made, both under local and general anesthesia, to obtain a direct view of the larynx, but these were all unsuccessful. A number of pieces were removed by the indirect method of the laryngoscopic mirror and curved forceps, after which prolonged local treatments were given. The whole category of chemical escharotics usually recommended for this condition was employed. The growths, however, speedily recurred. In fact, incomplete operation seemed to stimulate the neoplasm.

Accordingly, it was decided to do a laryngotomy, as the obstruction was becoming so pronounced. An incision was made and the larynx split, the growths were completely removed by the curette, and the seat of operation was thoroughly cauterized, after which the larynx was closed. Microscopical examination of the pieces removed showed that the growth was a benign papilloma. Recurrence, however, took place in a few weeks, with the return of so much obstruction that an emergency tracheotomy had to be performed. After the tube was inserted and the breathing relieved, the patient received a thorough course of x-ray treatments, but no beneficial effect was noted.

During the writer's absence in foreign service, the patient made two trips to a well-known western surgical center, where two unsuccessful attempts were made to introduce the direct laryngoscope. Inasmuch as it was impossible to remove the growth surgically, the patient was treated by applying radium externally. There resulted, however, no diminution in the size of the growths.

On the writer's return, examination of the patient showed that the epiglottis was completely covered on its posterior surface with villous excrescenses, and the interior of the larynx could not be seen, the opening being blocked by the growth. Neither the false nor the true vocal cords could be distinguished. The patient, at this time, had worn the tracheotomy tube continuously for a period of five years. During this time, she had given birth to two children, with no seeming inconvenience from the constant wearing of the tracheotomy tube.

---

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

In considering the case from its various aspects, it seemed futile to attempt further surgical treatment, and as the *x*-ray and external application of radium had been unsuccessful, it was decided to attempt the introduction of the radium capsule into the interior of the larynx. The introduction of the capsule with laryngeal forceps presented certain difficulties, as did also the introduction of the radium capsule on a semi-flexible bougie. Accordingly, the tracheotomy tube was removed for a few minutes and a small, flexible bougie was introduced into the trachea, the bougie was passed upward through the larynx and seized by forceps and drawn out through the mouth. A strong thread was then attached and pulled down through the larynx and out through the tracheotomy opening. The radium capsule, with its rubber filter, was then attached to this ligature, and pulled downward by the thread until the capsule was seen by the mirror to be wedged in the superior opening of the larynx. Twenty-five miligrams of radium placed in a rubber filter were allowed to remain in position of one and a half hours. The patient was given a preliminary dose of morphia to quiet the cough resulting from the introduction of foreign material in the larynx. The tracheotomy tube was re-introduced and the lower end of the thread was attached to the tube, while the upper end of the thread was anchored to one of the teeth. In this way, the radium capsule was held immobile during the hour and a half of treatment.

Considerable reaction followed the first séance, but at examination about one month later it was found that the epiglottis was practically clear of papillomata. At the second séance, the radium capsule was drawn well down into the larynx, with the dosage of twenty-five milligrams for one hour. This was followed by only a mild reaction, and partial disappearance of the laryngeal growths. The true and the false vocal cords then became visible.

A third treatment was given after a period of two months, with a similar dosage.

After three treatments, the patient's larynx was practically free of growths, although a few small tags remained, which will be subject to further irradiation. During the past week, a letter was received from the patient in which she states she is now able to dispense with the tracheotomy tube for one-half day at a time.

In presenting this case for discussion, and in giving the case history, we believe that we have, in the intralaryngeal application of radium, a powerful agent for the destruction of chronic, recurrent laryngeal papillomata.

From the laryngological standpoint, papillomata may be divided into two great groups; first, those which are easily amenable to surgical treatment and which do not tend to recur after removal, and, second, those which show a remarkable tendency to recurrence even after the most thorough surgical removal and cauterization. It is in the treatment of this second group of cases, which fortunately are somewhat rare, that the above procedure is recommended.

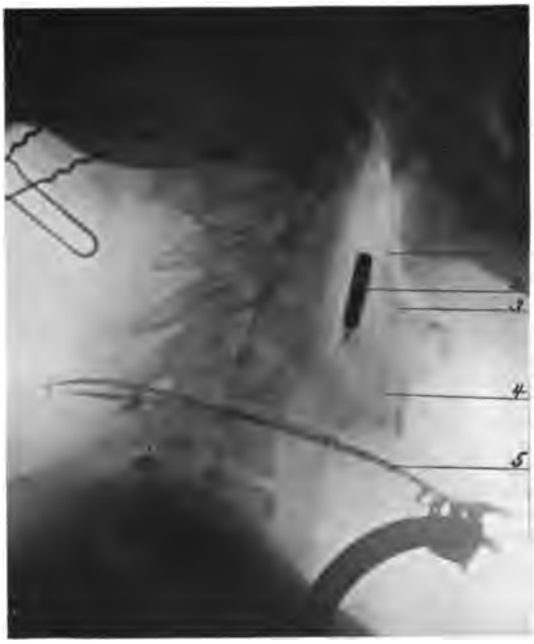
"Rapid and extensive recurrence in histologically benign form is observed especially in children, and illustrates the remarkable regenerative powers of the laryngeal epithelium. Laryngotomy and excision or cauterization has been performed three, four, and even seven times in a relatively short period before the disease could be arrested (Wilkinson, Lendon, Clubbe). In this group of cases, radium treatment has given excellent results." Ewing, *Neoplastic Diseases*.

From a purely theoretical standpoint, owing to the slight ability of the radium rays to penetrate tissues, it would seem useless to apply radium externally to the larynx, and this was found to be true in this particular case. The procedure here recommended, viz., the introduction of a stout thread through the laryngeal and tracheal opening and the immobilization by this means of the radium capsule in the larynx, offers we think a practically sure method of cure of these hitherto intractable cases.

With regard to the technique employed, it is necessary thoroughly to cocainize the laryngopharynx and also the trachea through the tracheotomy opening. At the same time, the patient should be given enough anodyne to keep the cough reflex in abeyance. The observation of the position of the radium capsule in the larynx was difficult when the ordinary laryngeal mirror was employed. Accordingly, it was found more practicable to place the patient before the fluoroscope and, after orientation of the shadow of the epiglottis and of the glottic opening, the position of the radium capsule could be accurately determined. If the capsule was placed too high, it could be readily drawn down by traction on the ligature through the tracheotomy opening. This procedure was found to be much more comfortable for the patient and far more accurate than observation with reflected light. In the introduction of the bougie, it was found much easier to introduce the bougie from below upward, making use of the tracheal opening.

Since the employment of the intralaryngeal applications in this case, the writer has had the opportunity of using the radium capsule in an advanced case of carcinoma of the larynx, where a tracheotomy had been performed for the relief of obstruction to breathing. In this case, it was difficult to introduce the bougie through the tracheotomy opening up into the larynx. Acordingly, the tracheotomy tube was reinserted with the tracheal end pointing upward, this permitting the bougie to pass upward into the larynx. This procedure had to be performed expeditiously, inasmuch as the patient's respirations were, of necessity, cut off.

While the observations on the effect of the treatment of carcinoma by the radium capsule are as yet incomplete, the fact remains that it is perfectly feasible to retain in this way any desired quantity of radium in intimate contact with the diseased tissue for any length of time desired.



1. Epiglottis.
2. Radium Capsule.
3. Hyoid Bone.
4. Thyroid Cartilage.
5. Chain for Retaining Tracheotomy Tube.

Where it is not desirable to perform a preliminary tracheotomy, it is possible to use an intubation tube having a groove cut in its side for the holding of the radium capsule. The method described above, of intralaryngeal application is only put forward as a suggestion for treatment in cases where all other methods have failed.

OBSERVATIONS ON THE BEHAVIOR OF THE NORMAL PYLORIC SPHINCTER IN MAN*

By C. W. McCLURE, M.D., and L. REYNOLDS, M.D.

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EXPERIMENTAL studies on the physiological factors influencing the motor functions of the gastro-intestinal tract and the relation of these motor phenomena to the digestion and absorption of food products have been largely carried out on animals. But the results obtained from such studies can be applied only in a general way to the physiology of the digestive tract in man. It follows that more intimate knowledge concerning various phases of the physiology of the alimentary canal in man would aid in the interpretation of results obtained from experimental studies of the pathological physiology of human digestion. For this reason certain phases of the motor functions of the normal stomach in man were studied. The present preliminary report largely deals with work bearing on the question of "acid control" of the pyloric sphincter in man.

Cannon elaborated the theory, suggested by Pawlow among others, that acid controlled the action of the pyloric sphincter in animals. In epitome this theory is that the presence of acid in the antrum of the stomach causes relaxation of the pyloric sphincter, while the presence of acid in the duodenum causes the sphincter to contract. The evidence on which this theory is based was obtained from experiments carried out on animals. Phenomena occur in animals which the theory of "acid control" does not explain, and for this reason other controlling factors are assumed to exist. Whether or not acid or some other factor exerts the principal control over the pyloric sphincter in man has not been demonstrated, and with the problem the present investigation is concerned. The results obtained by previous investigators will be discussed later.

The object of the present study has been to determine:

1. The degree of contraction of the pyloric sphincter when foodstuffs partially fill the normal stomach.
2. The behavior of the sphincter relative to the passage of carbohydrate, protein, or fatty foods from the normal stomach into the duodenum.
3. The effect on the pyloric sphincter of direct application of hydrochloric acid and sodium bicarbonate solutions to both its antral and duodenal ends.

These observations of the stomachs of normal persons were made by means of the fluoroscope after feeding meals composed of thick porridge and barium or 140 gm. of ground lean meat and 4 gm. of barium sulphate baked into a loaf, or 120 gm. of ground fatty bacon, 5 egg yolks and 40 gm. of barium sulphate baked into a loaf. The protein and fatty meals were of constant bulk and consistency.

1. *The degree of contraction of the normal pyloric sphincter.*— That the pyloric sphincter is closed when fluid food is in the stomach, except during the periods in which it opens to permit the ejection of food into the duodenum, was demonstrated in 1913 by Cole. His observations were so readily and easily confirmed by fluoroscopic studies that they are now universally accepted. The authors have confirmed Cole's observations by means of the fluoroscope a large number of times. Further evidence that the normal quiescent sphincter is in a state of contraction is afforded by the fact that barium mixtures can be forced from the stomach into the duodenum only by the use of consider-

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able pressure on the abdominal wall and only when the sphincter has opened in relation to the advance of an antral peristaltic wave. When this is successful the filled antrum and first portion of the duodenum are seen to be connected by a narrow isthmus of barium, which represents the lumen of the sphincter; on cessation of pressure this narrow isthmus disappears.

2. *The behavior of the pyloric sphincter relative to the passage of carbohydrates, protein and fatty foods from the stomach into the duodenum.*—In the routine clinical *x*-ray examination of the stomach a carbohydrate meal consists of 500 c.c. of malted milk solution in which 90 gm. of barium sulphate are held in suspension by the aid of potato starch. The meal starts through the normal pyloric sphincter immediately or within a few minutes after it has been ingested. The normal sphincter opens regularly, as each antral peristaltic wave approaches, and permits the passage of the barium meal into the duodenum over a period of about ten seconds. In two young men with normal stomachs the same phenomenon occurred after the ingestion of thick oatmeal porridge mixed with barium. Except in abnormal conditions accompanied by pylorospasm, opening of the pyloric sphincter at irregular intervals, as described by Cannon in cats, was not observed. The regular opening and closing of the pyloric sphincter, except in the presence of pylorospasm, is so well known that no further work on carbohydrate meals was deemed necessary in the present investigation.

Observations on the behavior of the pyloric sphincter after the ingestion of protein food were made on eleven young men, ten with normal stomachs, one with a quiescent duodenal ulcer, and one woman whose stomach was normal.

Similar observations were made after the ingestion of fatty food in six normal young men. The duration of each experiment varied from thirty minutes to six hours. In these experiments the food was seen to pass from the stomach into the duodenum in normal amounts as each peristaltic wave approached the pyloric orifice. By normal amounts is meant that quantity of barium which passes through the pyloric sphincter after the ingestion of the barium meal commonly used in an *x*-ray examination for diagnostic purposes. The amounts of foodstuffs and of water fed in these experiments formed a very thick mush when thoroughly mixed together in a mortar. To obviate the criticism that the consistency of the food permits it to act more like liquid than solid foods, the meat and fatty meals were administered without the addition of water. The result obtained was the same, namely, the foodstuffs began to pass through the pylorus immediately.

Our observations seem to indicate that both fatty and protein meals begin to leave the stomach within three to ten minutes after the food has been swallowed. Furthermore, the food passes through the sphincter into the duodenum as each peristaltic wave approaches the pylorus. The amounts of a single food or of different ones which pass through the sphincter during a given time do not vary in the same individual.

3. *The effect of hydrochloric acid and sodium bicarbonate solutions on the pyloric sphincter.*—Solutions of hydrochloric acid and in a few instances of sodium bicarbonate were introduced into the duodenum and the effect on the opening and closure of the pyloric sphincter was ascertained. The behavior of the sphincter was constantly observed through the fluoroscope. The activity of the sphincter was determined by the passage or non-passage of barium from the stomach into the duodenum.

The subjects used were hospital patients whose physical condition at the time of the experiments was considered to be normal. The usual gastric analyses of these patients showed no abnormalities.

The observations on the effect of hydrochloric acid and sodium bicarbonate solutions on the pylorus were made as follows: the duodenal tube was passed subsequent to a twelve hour fast; the tube was allowed to pass into the duodenum. The time required for the tube to pass from the stomach into the duodenum was variable; at times it was only a question of minutes and at others it required an hour or more. After the tube had entered the duodenum a meal was fed.

The meal consisted of a meat and barium meal either rinsed down with 200 c.c. of water or made in a mush by grinding in a mortar with 100 c.c. of water. In certain cases, where the subject was unable to eat the whole meal prepared, we gave an additional malted milk, potato starch and barium mixture to enable us more completely to visualize the sphincter; however, this was necessary in only two cases.

After the patient was observed a sufficient length of time to determine that the peristaltic waves were orderly and regular we began the instillation of solutions of hydrochloric acid and sodium bicarbonate. In some instances an N/40, in others N/20 and in one case an N/10 hydrochloric acid warmed to body temperature was instilled in from 5 c.c. to 20 c.c. amounts into the first, second and third portions of the duodenum. The time of the instillation was varied in relation to the normal opening time of the pyloric sphincter. In some cases an injection was made just prior to the normal opening time of the pyloric sphincter and this was gauged by the observation under the fluoroscope of the advance of an antral peristaltic wave. In other instances the instillation of 20 c.c. of the acid was begun as an antral peristaltic wave reached the sphincter and the instillation continued until the sphincter had opened and closed several times. In another series of experiments a 1 per cent solution of sodium bicarbonate was used in place of the acid and the pylorus was similarly observed. In these experiments on four individuals no effect was observed on the opening time of the sphincter, the amounts of barium passing through it, or upon its time of closure. It will be seen consequently that the behavior of the sphincter is the same whether acid or alkali is introduced into the duodenum. In a fifth subject the introduction of N/20 hydrochloric acid or of 1 per cent sodium bicarbonate into the first portion of the duodenum produced either complete or partial pylorospasm and vigorous duodenal antiperistalsis. This rather unexpected behavior was subsequently explained by the discovery of a duodenal ulcer. In a subject the introduction of N/20 hydrochloric acid into the third portion of the duodenum produced either complete or partial pylorospasm associated with the development of very shallow gastric peristaltic waves. In one subject a loop of the duodenal tube passed through the sphincter into the duodenum leaving the metal tip in the antral end of the pyloric sphincter. This permitted solutions to escape from the orifice of the tube directly onto the antral portion of the sphincter.

DISCUSSION

Our observations demonstrate that finely divided foods, regardless of whether they are solid or liquid, begin to leave the stomach within a very short period of time. Thus barium was observed to pass the sphincter in the time required for the subject to ingest the meal and be prepared for fluoroscopic observation, which was always less than ten minutes. It was of interest to observe that carbohydrates, fats and proteins behaved alike in this respect—contrary to what one would expect from reports of animal observations. That this phenomenon is true for carbohydrate meals has already been stated. But with the exception of Cole no observations in man of other types of meals have been published, and his publication unfortunately gives no experimental details. The barium meal passed through the pyloric sphincter as each antral peristaltic wave approached that orifice. Cole has previously made similar observations. The opening of the pylorus at irregular intervals, as described by Cannon in cats, was not noted. It was observed that the antral portion of the stomach was quiescent except for peristaltic waves which at regular intervals swept over it. The contents of the antrum were consequently not undergoing a mixing process and the same food must have remained in contact with the gastric mucosa. Therefore, the surface of the antral mucous membrane would be covered with material of a fairly constant degree of acidity. It is very probable that the reaction of this material is acid. This statement is based upon the following facts:

1. The authors have found in two subjects, after feeding a meat meal, the food when first ejected from the stomach into the duodenum to contain free hydrochloric acid in the strength of N/60 and N/500. The position of the metal tip of the duodenal tube and the phenomena transpiring in the stomach and duodenum at the time the specimen for analysis was withdrawn were determined by fluoroscopic observation.

From the above it follows that in order for the stimulation of acid in the stomach to open, and in the duodenum to close the sphincter, there must be assumed the existence of a very delicate balance between the antral and duodenal reflexes in relation to the presence of the same degree of acidity, the duodenal reflex being much the more sensitive.

McClendon and Meyers and the authors have found the contents of the first portion of the human duodenum to be either neutral or of low acidity. After emptying itself of food just ejected from the stomach the duodenum will, therefore, be practically neutral in reaction, and in the presence of pancreatic juice possibly alkaline. Then if acid in the stomach causes the sphincter to relax, the sphincter should become patent when the duodenum empties itself of food. That this is not the case is demonstrated by the difficulty experienced in pushing barium through the sphincter into the duodenum by palpation of the abdominal wall. In fact, it is probable that barium can be caused to enter the duodenum by this means only when the sphincter opens in relation to the advance of an antral peristaltic wave. From this it follows that, if the pyloric sphincter is under "acid control," then the fact that it opens at regular intervals and normally only in a definite relation to the advance of an antral peristaltic wave makes it necessary to assume either (1) that there is a finely adjusted acid regulatory mechanism in the antral region of the sphincter which produces the proper degree of acidity to relax the sphincter at a fairly exact time in relation to the approach of a peristaltic wave toward the sphincter; or (2) that a comparable mechanism for properly neutralizing the contents of the duodenum must exist. If either or both such mechanisms exist they must be so adjusted as to permit of changes in the rhythm of the time of opening of the sphincter, as occurred in one of our experiments after pouring alkali onto the end of the pyloric sphincter. Furthermore, while the sphincter closes suddenly it remains open an appreciable length of time. Barium flows through the sphincter as an antral peristaltic wave approaches and continues to do so until the wave has spent itself. The sphincter, therefore, does not close as soon as acid enters the duodenum, and the presence of acid we have demonstrated experimentally. If acid in the duodenum causes closure of the sphincter then either (1) the proper degree of acidity must be always developed at a time when an antral wave has spent itself, or (2) a secondary mechanism in some way regulating the reflex must be assumed.

The existence of the various factors outlined are necessary to explain the theory of "acid control" of the sphincter, and their existence has not been proved. The assumption of the existence of these factors renders the mechanism of the control of the sphincter exceedingly complex. It is possible that some other less complicated mechanism may exist in man. The latter has been suggested, but not proved, by Luckhart, Phillips and Carlson. These investigators found that a relation exists between the muscular activity of the antrum and the opening of the sphincter.

In four of the experiments here reported it has been shown that acid introduced into the duodenum did not prevent the opening of the sphincter. These observations do not support the theory that acid in the duodenum causes contraction of the pyloric sphincter. Furthermore, sodium bicarbonate was poured into the duodenum in a quantity which, judging from the limited observations of the degrees of acidity of the duodenal contents, was sufficient to bring about neutralization. The latter must have occurred in an experiment in which 5 per cent sodium bicarbonate solution was allowed to flow into the duodenum. The carbonate solution was introduced on two occasions in quantities of 10 c.c. and 20 c.c. after the pyloric sphincter had opened and up to the time of its complete closure. Before the introduction of the carbonate solution the chyme was collected as it was poured into the first portion of the duodenum during the latter half of the time the sphincter remained open. This allowed the first portion of the chyme to clear the region of the metal tip of duodenal contents. The concentration of free hydrochloric acid in the chyme was N/500, and of total acidity N/25 (titrated to phenolphthalein). According to the "acid control" theory, the sphincter should have remained patent as long as the duodenal contents in these experiments were alkaline. This it did not do, but was observed to close completely. However, absolute evidence that the amount of carbonate introduced neutralized all the acid in the duodenum could not be obtained, although but little doubt can exist that neutralization was effected.

CONCLUSIONS

Conclusions drawn from the experimental work here presented are as follows:

1. Finely divided carbohydrate, protein or fatty foodstuffs begin to leave the normal human stomach within from three to ten minutes after their initial ingestion.

2. Under normal conditions the human pyloric sphincter opens regularly at the approach of each antral peristaltic wave, allows chyme to pass through into the duodenum during an appreciable length of time, and closes when the antral peristaltic wave has spent itself.

3. The introduction of N/40, N/20 or N/10 hydrochloric acid solutions into the first, second or third portions of the normal human duodenum either produced no effect on the opening of the pyloric sphincter as observed by means of the fluoroscope, or produced effects which were interpreted as the result of abnormal irritation of the duodenal mucosa.

4. Neutralization of the contents of the first portion of the duodenum did not prevent the closing of the pyloric sphincter.

5. The experimental results obtained offer evidence that acid is not the principal factor controlling opening and closing of the pyloric sphincter in man.

LEATHER-BOTTLE STOMACH (LINITIS PLASTICA)*

REPORT OF FIVE CASES WITH REMARKS ON RELATIONSHIP TO SYPHILIS AND CANCER OF THE STOMACH

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NEW YORK CITY

IN view of the number of recently reported cases of syphilis of the stomach, which simulates in appearance that of the leather-bottle stomach, it seems advisable to revise our ideas of the roentgen diagnosis of this condition.

Despite the difficulty of attempting to differentiate by roentgen methods alone diffuse infiltrating scirrhus carcinoma from syphilitic infiltration, or fibrous infiltration of the stomach, it is, nevertheless, possible to distinguish these cases one from the other in a large enough proportion of cases at least to facilitate and augment clinical diagnosis; and in many instances it is possible to make an absolutely correct diagnosis when taken in conjunction with the Wassermann test.

The leading monographs on leather-bottle stomach have been and are based largely upon clinical, operative or postmortem evidence; but with the addition of roentgen methods of study of living pathology, which permit of diagnosis in life, heretofore not possible, our knowledge of the subject is considerably supplemented.

The term "leather-bottle" appears to be based upon the consistency and thickness of the stomach wall rather than from any definite resemblance to our modern bottles; though the narrowing of the pyloric end of the stomach and a compensatory widening of the cardiac end would seem to be the reason for calling it a "leather-bottle" stomach, after the leathern water bottles of the early Egyptians. Schrumpf (1876) calls it "field-canteen" stomach.

Dr. H. H. M. Lyle[1] in 1911 collected seventy cases, described under the term linitis plastica or cirrhosis of the stomach, and reported a case cured by gastrojejunostomy. This case has been under observation for nine years and is still alive, Dr. Lyle informs me.

Carman[2] (1920) has reported three cases.

From our roentgenologic observation of these cases, it appears that the peculiar type of stomach to which the term "leather-bottle" has been applied may represent any one of three conditions: first, fibromatosis; second, syphilis; third, diffuse carcinoma.

Cases illustrating these three types together with the roentgen findings are reported below:

CASE HISTORIES

CASE I. LEATHER-BOTTLE STOMACH DUE TO FIBROMATOSIS.—H. O., female, aged fifty. Seven months prior to admission to St. Luke's Hospital the patient noticed a tumor in the epigastrium, which on examination was found to be firm, movable and nontender. There was no complaint of pain, vomiting, nausea, sour eructations or jaundice. Solid foods caused gastric distress followed by some belching of gas; there were several bloody stools but no tarry ones; a loss of forty-five pounds in one year. The general appearance was that of a fairly well nourished, not acutely ill woman.

Gastric analysis, free HCl—0, total acidity —30.

Roentgen examination revealed a deformity of the horizontal portion of the stomach involving about one third of the stomach wall. (Fig. 1). It was very smooth and resembled closely a specific infiltration. Both the greater and lesser curvatures were involved. The stomach emptied at an exceedingly rapid rate, the meal meeting with practically no delay at the pylorus, so that in five minutes the small intestine was filled. The duodenum was slightly dilated. At the cardiac end of the stomach there was some irregularity about the entrance to the esophagus, suggesting infiltration of this region. The stomach practically emptied itself in one hour. At the sixth hour the meal had reached the hepatic flexure. A considerable portion of the meal had been eliminated at the twenty-fourth hour.

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[1] *Annals of Surgery*, Nov. 1911.

[2] CARMAN AND MILLER. Roentgen Diagnosis, Diseases of the Alimentary Canal. Saunders, 1920.

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14-17, 1920.

A confirmatory examination showed the deformity of the stomach persisting and fluoroscopic examination showed the mass in the abdomen to be related to the deformity of the stomach wall.

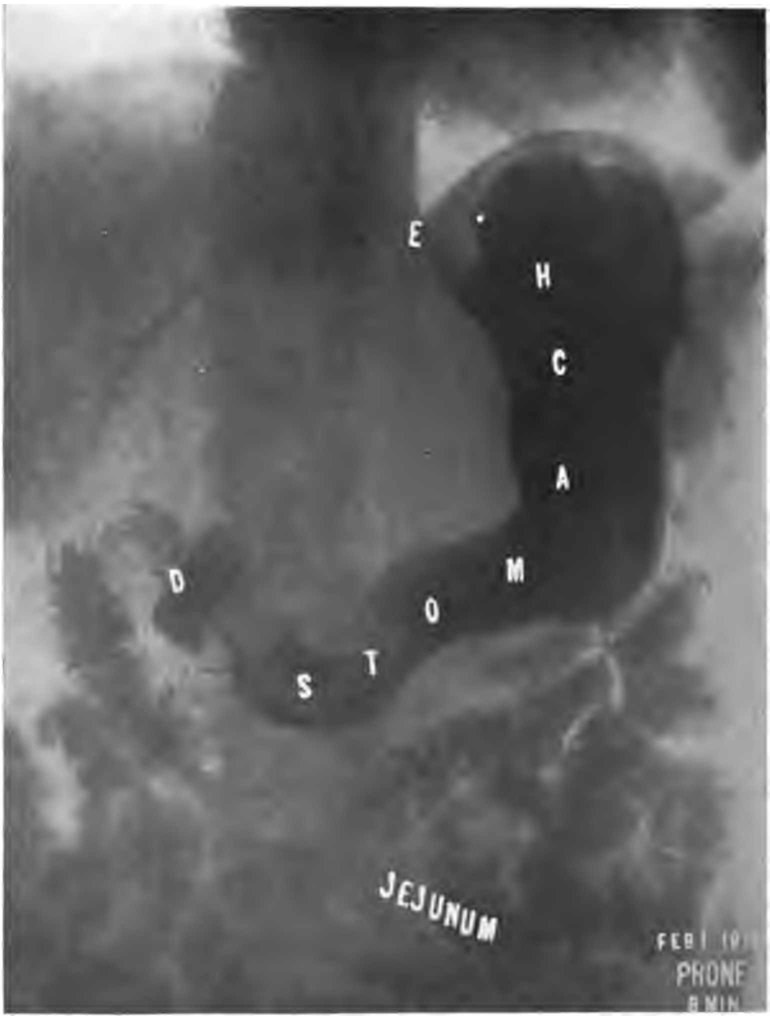

Fig. 1. Case I. Leather-Bottle Stomach Due to Fibromatosis. Eight minutes after meal. Deformity of stomach involving greater and lesser curvatures. Irregularity at esophageal entrance indicating infiltration. Microscopic examination showed increase in fibrous tissue but *no evidence of cancer.*

Preoperative clinical diagnosis: Carcinoma of the stomach. At operation the stomach was found infiltrated with a large tumor mass extending over the lesser curvature from the cardia to the pylorus. Lymphatics dilated, but no enlarged or palpable glands; no epigastric adhesions. Incision made in the stomach just above the pylorus and two small pieces removed for microscopic examination.

Pathologic examination of the specimen taken from stomach wall showed considerable thickening, apparently in the submucosa. The mucosa appeared normal and the serous coat was smooth and shining. The smaller fragment consisted only of mucosa and submucosa. The latter was greatly thickened. There was no evidence of any gross lesion.

Microscopic examination of the specimen showed that there was a very considerable increase in the fibrous tissue of the submucosa. This was very thick, rather dense, contained large fibroblastic nuclei which were well stained and gave the form of cellular tissue. The mucosa was normal overlying this, or in some places was slightly hypertrophic. Blood vessels were only moderately thick-walled, showing comparatively little change. There was no perivascular infiltration, and only very little infiltration of the fibrous tissue, except along the deep surface of the mucosa where there were rather numerous lymphocytes. The pathologic lesion appeared only as a diffuse overgrowth of fibrous tissue.

No cells suggestive of a neoplasm could be detected in the section.

Patient was placed on anti-syphilitic treatment in spite of the negative Wassermann examination. No improvement resulted.

Roentgen examination five weeks after operation and about three weeks after the beginning of treatment showed practically no change in contour or emptying time of the stomach. (Fig. 2.)

Eleven months later the patient returned to the hospital complaining of abdominal distention of two months' duration, combined with a swelling of the legs for two weeks. She was able to take only a small amount of food at a time. There was no dyspnea or cardiac distress; no jaundice, pain or constipation. The lump in the epigastrium was still present. She gained in weight after the operation but then became so weak she was quite unable to walk.

Physical examination: patient fairly well nourished and developed; not acutely ill; no cyanosis, jaundice or dispnea. Abdomen was distended, tense, dull in flanks; fluid was present in epigastrium; irregular, large mass just above umbilicus; no rigidity. Gastric analysis: free HCl—0; total acidity—10.

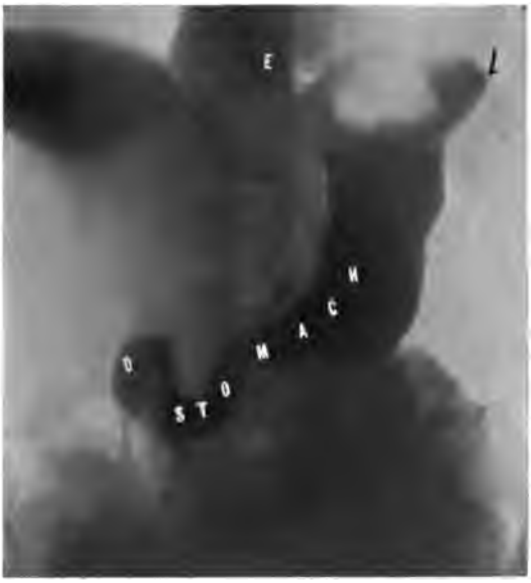

Fig. 2. Case I. (Same case as Figure 1.) Fibromatosis. Five weeks after exploratory operation and removal of section. Ten minutes after meal. Practically no change in contour or emptying time of stomach.

Fluoroscopic examination showed distinct delay in the esophagus, indicating spasm or organic constriction at the cardiac end of the stomach.

Roentgen examination: the stomach remained very small as noted at previous examination. The greatest transverse diameter of the stomach was only 5 cm. This confirmed the diagnosis of leather-bottle stomach. Greater curvature 3 inches above the umbilicus. At the fourth hour, the stomach was entirely empty. No delay in the ileum.

The colon was sluggish. Most of the meal remained in the transverse portion of the colon at the twenty-fourth hour.

At the forty-eighth hour some of the meal had reached the sigmoid. Traces remained in the transverse portion of the colon.

The abdomen was aspirated and 10 c.c. of fluid removed. No operation. No medication, except tonic. Rest.

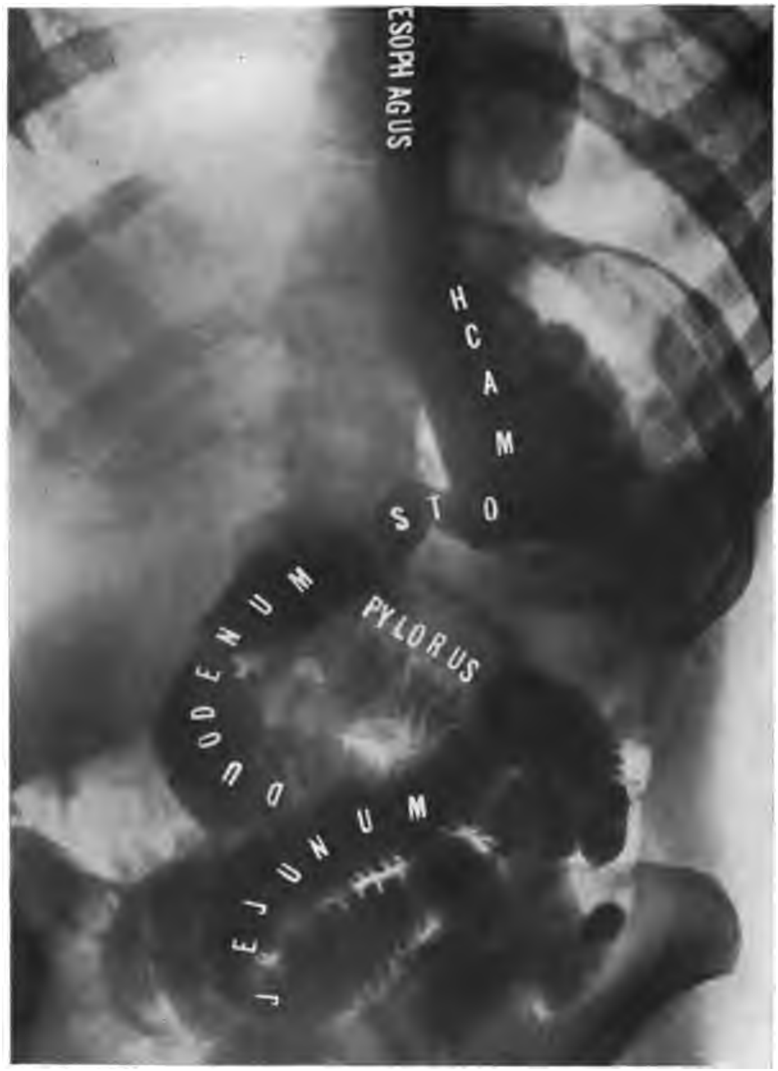

FIG. 3. CASE II. LEATHER-BOTTLE STOMACH DUE TO SYPHILIS. (AGED TWENTY-THREE.) Two minutes after meal. Note diminished size of stomach with compensatory dilatation of esophagus and rapid passage of the meal through the pylorus.

CASE II. LEATHER-BOTTLE STOMACH DUE TO SYPHILIS.[3]—M. A., female, aged twenty-three, married. Case referred for roentgen examination from the medical service of St. Luke's Hospital, New York, by Dr. Samuel Lambert on September 29, 1914, with a provisional diagnosis of gastric ulcer.

History: Patient had suffered from pain and vomiting for two years with a loss of fifty pounds in weight. Four months previously she had had a therapeutic abortion performed *for persistent vomiting* and a similar occurrence once before that, three months after her marriage. Whenever she took food she was seized with a sharp pain in the epigastrium followed by vomiting in about fifteen minutes, which relieved the pain. Test meal: blood, 0; lactic acid, 0; free HCl, 0; total acidity, 14.

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[3] This case is one of a group of cases of syphilis of the stomach reported in AMERICAN JOURNAL OF ROENTGENOLOGY, February 1917, iv, 76, by the author.

Roentgen examination showed a peculiar deformity involving the pyloric half of the stomach. (Fig. 3.) This region appeared to be infiltrated, together with the pyloric ring which is held open allowing the food to pass out of the stomach in a most remarkable manner. At the sixth hour there was a small residue high up in the cardiac end of the stomach. Syphilis of the stomach was diagnosed and a Wassermann examination advised. It was reported four plus.

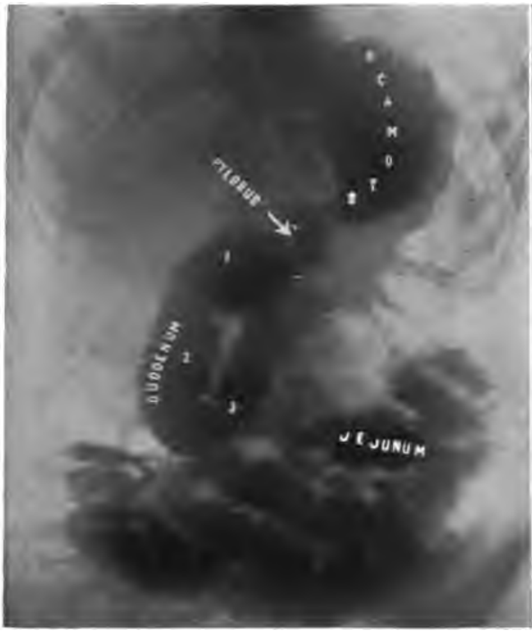

FIG. 4. CASE II. (Same case as Figures 3 and 5.) SYPHILIS. (AGED TWENTY-THREE.) Confirmatory examination. Five minutes after meal.

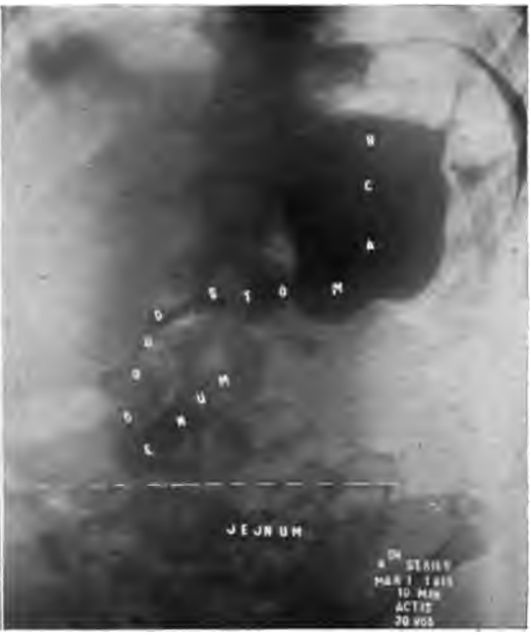

FIG. 5. CASE II. (Same case as Figures 3 and 4.) SYPHILIS. (AGED TWENTY-THREE.) Five months after medical treatment. Ten minutes after meal. Cessation of symptoms. Increase in size of stomach with less rapid emptying.

On October 5, 1914, a confirmatory examination was made. This duplicated the finding of a peculiar deformity involving the pyloric half of the stomach causing a considerable narrowing of the lumen, an appearance which is characteristic of syphilis of the stomach. (Fig. 4.) On November 11, 1914, another examination was made after the patient had been placed on anti-spyhilitic treatment following the findings of a positive Wassermann reaction. Nausea and vomiting had ceased and weight had been gained. Roentgen examination showed the peculiar deformity of the stomach persisting and at the sixth hour there was a small residue at the cardiac end of the stomach.

March 1, 1915, patient remarkably improved, had gained forty-four pounds in weight, and was entirely free from pain and vomiting. Roentgen examination showed the deformity at the pyloric end of the stomach still persisting and the stomach emptying at a very rapid rate. (Fig. 5.) At the sixth hour there was a very small residue in the cardiac end of the stomach, very much as in the earlier examination.

February 16, 1916, roentgen examination showed still further improvement in the size of the stomach, indicating some absorption of the infiltration. This was particularly evident about the pylorus, the sphincter having regained its function so that food passed through it at about a normal rate instead of at the excessive rate previously noted. She was free from all stomach symptoms and had gained fifty-four pounds in weight.

November 20, 1916, gave birth to a healthy child.

Case III. Leather-Bottle Stomach Due to Carcinoma in a Girl Twenty-three Years of Age.[4]—D. V., admitted to St. Luke's Hospital March 24, 1919, with a clinical diagnosis of anemia. Possible cause, carcinoma of the stomach or splenomegaly.

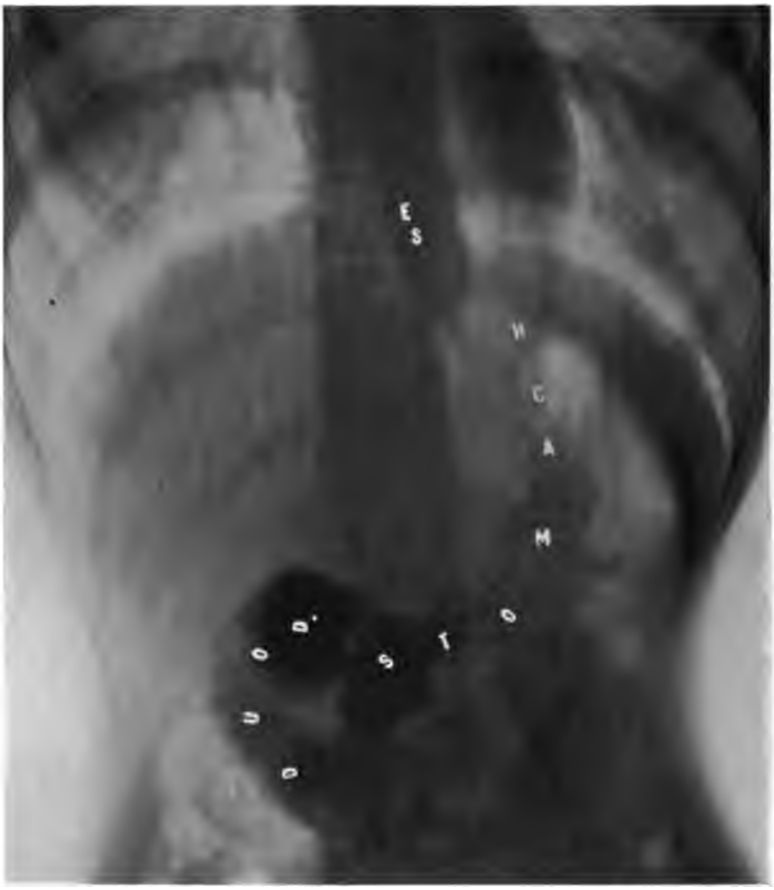

Fig. 6. Case III. Leather-Bottle Stomach Due to Carcinoma, in a Girl Twenty-three Years of Age. Two minutes after meal. Note dilatation of the esophagus, diminished size of stomach with rapid emptying. Microscopic examination: carcinoma.

History: four months ago patient began to suffer from indigestion, especially noticeable about one-half hour after meals and lasting from one to one and a half hours. At first there was no nausea or vomiting, but later it was accompanied by incessant vomiting. There was no blood in the vomitus. There was marked loss in weight.

Physical examination; a very poorly nourished adult female, decidedly pale, with drawn features. Abdomen: there was a mass in the epigastrium extending to the left side and palpable two inches below the costal margin. It moved with respiration and had a very distinct edge. It appeared to represent either the left lobe of the liver or the spleen. Wassermann reaction negative. Gastric analysis: free HCl—0; total acidity—0.

Roentgen examination: the fluoroscope revealed a most remarkable condition. The opaque meal passed immediately out of the stomach. The condition resembled very closely that observed in several cases of syphilis of the stomach. The opaque meal examination confirmed the fluoroscopic findings of a remarkably small stomach with a gaping pylorus. So rapid was the emptying of the stomach that a roentgenogram was made with extreme difficulty, taken while the patient was in the act of swallowing and prone on the table. (Figs. 6, 7, 8.) The stomach as thus outlined measured only about 11 by 3 cm. Eight days later a confirmatory examination was made with the patient in the prone position. A partial filling of the esophagus could be made out, suggesting some attempt at compensatory dilatation to make up for the small-sized stomach.

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[4] This is the earliest age in which carcinoma of the stomach has been observed by the author. A case at the age of fifteen years is abstracted in the *Journal of the American Medical Association*, April 2, 1921.

The patient was operated upon April 23, 1919. The duodenum, pylorus and distal inch of the stomach were apparently normal. Proximal to this was a lump which was sharply marked by a hard indurated line. The stomach was contracted and the walls were the seat of nodular induration which felt carcinomatous to the operator. Surrounding the stomach there were a few hard nodes. The stomach was closely adherent to the under surface of the liver. A jejunostomy was performed and a tube inserted.

Pathological examination. Specimen removed at operation consisted of a small node from the greater curvature with considerable inflammatory tissue surrounding it. It was very firm and white on section.

Microscopic examination of the section showed a considerable amount of inflammatory tissue invading the fat. There was also a small lymph node which was almost entirely fibrous. This fibrous tissue and fat were diffusely invaded by small epithelial cells growing singly or in slender tubules apparently in the lymph vessels. They were only moderately hyperchromatic, the nuclei were rather large in proportion to the size of the cell, although the entire structure was comparatively small. Some of the blood vessels were very thick-walled and the coats were extensively invaded by these small cells. The fat appeared to be actively growing since there were numerous nucleated cells with a pale cytoplasm as well as fat vacuoles without nuclei. Diagnosis: Carcinoma in inflammatory tissue from greater curvature of stomach.

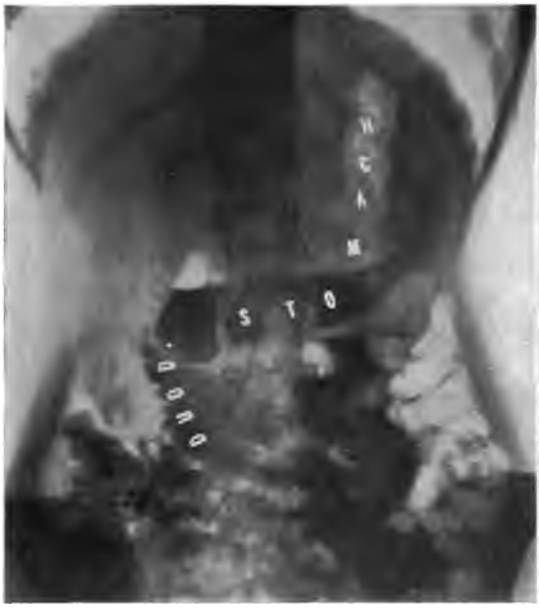

Fig. 7. Case III. (Same case as Figures 6 and 8.) Carcinoma. (Aged Twenty-three.) Six minutes after meal. Meal passing rapidly into jejunum.

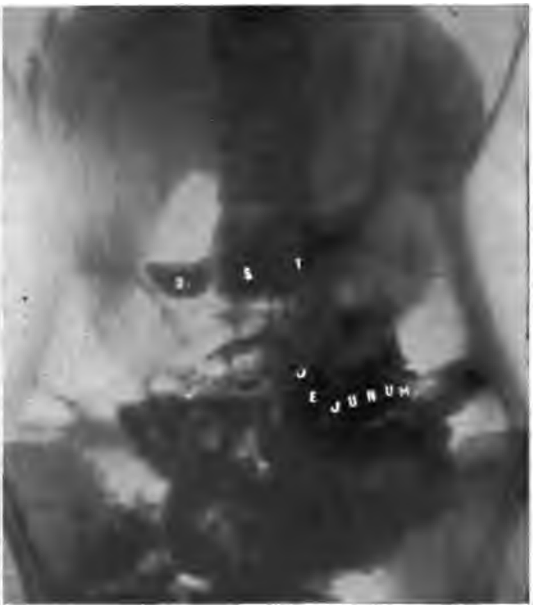

Fig. 8. Case III. (Same case as Figures 6 and 7.) Carcinoma. (Aged Twenty-three.) Eight minutes after meal. Stomach almost entirely empty.

In spite of the operative procedure the patient continued to lose weight and strength and died two weeks later. Autopsy revealed cancer of the stomach and the following notes were extracted from the autopsy record: The neoplasm began at the cardia. The cancer extended along the lesser curvature and stopped short about 3 cm. above the pyloric opening. The lesser curvature was greatly thickened. The omentum was firmly fixed to the greater curvature and a little of the fundus remained free from the growth. The pancreas was adherent to the stomach and on section appeared to be normal. The stomach was contracted, measuring but 10 cm. in its vertical axis. (Fig. 9.) The liver showed no evidence of metastatic involvement.

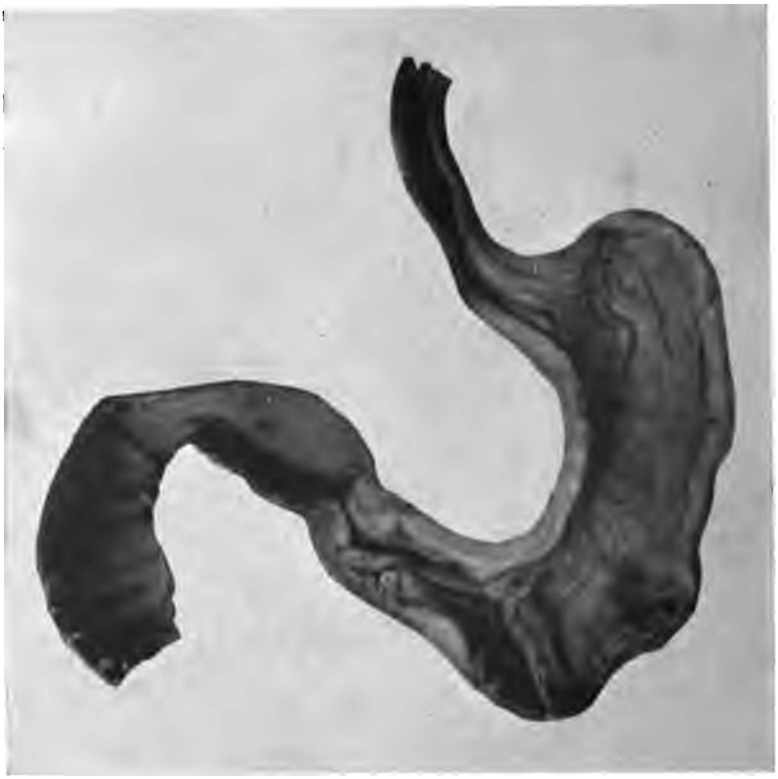

FIG. 9. CASE III. CARCINOMA OF THE STOMACH. (AGED TWENTY-THREE.) Photograph of stomach showing diminished size and thick wall.

[A fourth case of a very similar-shaped stomach has been encountered and explored surgically and the microscopic examination showed the presence of carcinoma of the peritoneum, but the exact site of the original tumor could not be determined. It probably originated in the stomach. The history is as follows:]

CASE IV. LEATHER-BOTTLE STOMACH PROBABLY DUE TO CARCINOMA.—C. M., male, aged fifty-six. Has complained of stomach trouble for nine months; suffered from vomiting and pain in the abdomen. Admitted to St. Luke's Hospital, July 12, 1919, under the service of Dr. Nathan Green.

Roentgen examination revealed a remarkably small stomach, measuring about 12 by 4 cm. in diameter. (Fig. 10.) The pylorus was gaping so that the duodenum and upper jejunum were filled within a few minutes. There was secondary dilatation of the esophagus. The findings were typical of leather-bottle stomach and closely resembled cases of syphilitic infiltration of the stomach wall. Wassermann was negative.

Exploratory laporotomy was performed

July 22, 1919, by Dr. Green. The abdomen was markedly distended. There was free fluid in the peritoneal cavity. The intestines were matted together owing to numerous adhesions and covered by minute carcinomatous growths. The stomach and transverse colon were matted together so that it was impossible to determine the primary seat of the carcinoma. Both the stomach and the transverse colon were infiltrated with the new growth. The liver was hard and nodular and studded with metastatic nodules. A section was removed for microscopic examination from the infiltrated omentum.

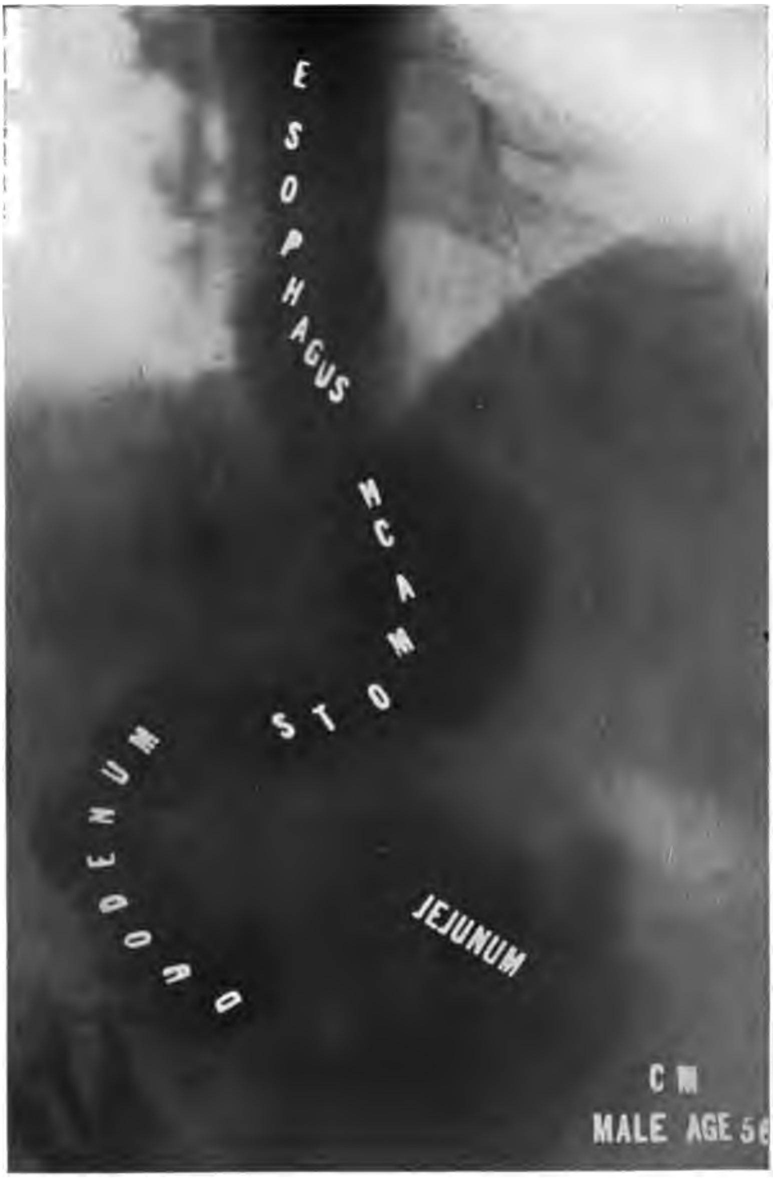

FIG. 10. CASE IV. LEATHER-BOTTLE STOMACH DUE PROBABLY TO CARCINOMA. Fifty minutes after meal. Note small size of stomach with compensatory dilatation of esophagus. Pathologic examination: metastatic carcinoma from abdomen; origin of growth not evident.

Microscopical examination reported by Dr. L. C. Knox. Section consisted of fatty tissue with extensive productive inflammation and large collections of lymphocytes, and throughout this a few infiltrating carcinomata cells. The cells were rather small and were found in small groups only, but the nuclei were large, hyperchromatic, and showed numerous mitoses. There was no tendency to form glands and no evidence as to the possible origin of the growth. Diagnosis: Metastatic carcinoma from abdomen.

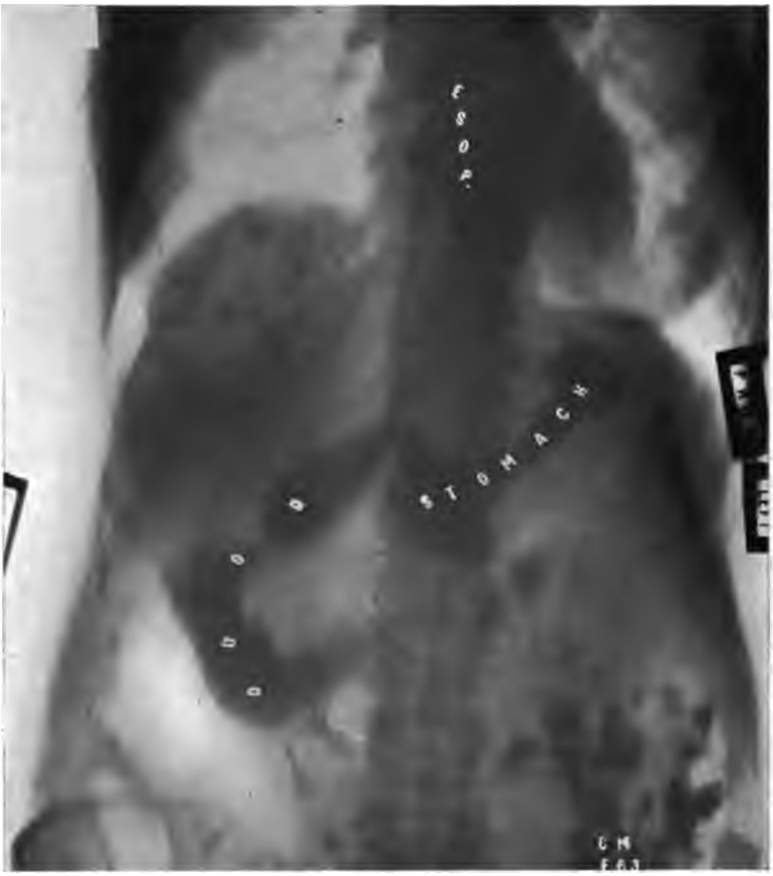

FIG. 11. CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?). Twenty-five minutes. Note small size and dumb-bell shape, very rapid emptying and compensatory dilatation of esophagus.

Discharged from the hospital August 7, 1919.

[Note: Just prior to publication of this article an additional case of leather-bottle stomach has been observed. The history is as follows:]

CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?).—C. M., female, aged sixty-three. The patient had suffered from vomiting for several months; no food in the vomitus, just mucus and apparently bile. The vomiting had become almost continuous and was without relation to the taking of food. It was impossible to obtain stomach contents for a gastric analysis. (The reason for this is very evident in view of the rapid emptying of the stomach shown radiographically.) Wassermann negative.

Roentgen examination: the lower end of the esophagus showed slight dilatation. (Fig. 11.) The stomach was exceedingly small and dumb-bell shaped. (Figs. 12, 13.) The pylorus was gaping so that the entire duodenum and upper jejunum were immediately filled. Moderate dilatation of the duodenum suggested some tendency to compensation for the small size of the stomach. Roentgen diagnosis: leather-bottle stomach —cause not evident.

A confirmatory examination made three days later showed the same appearance. No abnormality of the colon observed.

On account of the continuous vomiting the patient begged for operative relief. March 11, 1921 (two weeks later) a jejunostomy was performed by W. A. Downes. At operation the stomach was found to be greatly reduced in size and capacity, giving a typical leather-bottle appearance. The walls were extensively involved in what appeared to be a diffuse carcinoma. In the middle of the lesser curvature was a contracted area which suggested the site of a previous ulcer. No evidence of secondary nodules in the liver or lymph nodes, so that no material was obtained for microscopic examination.

Further report of this case may be made later.

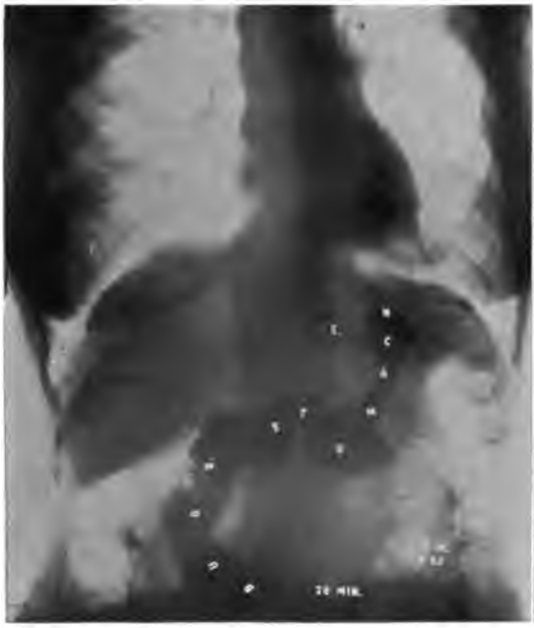

Fig. 12. Case V. Leather-Bottle Stomach Due to Carcinoma (?). Twenty-eight minutes. Dilatation of duodenum compensating for small size of stomach.

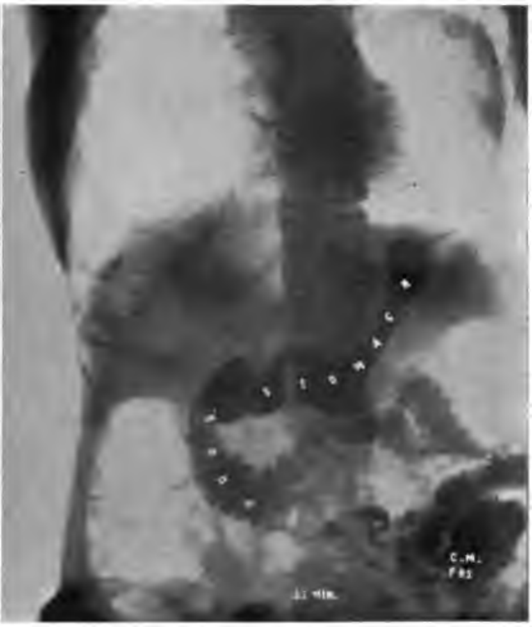

Fig. 13. Case V. Leather-Bottle Stomach Due to Carcinoma (?). Thirty-two minutes. Note dumbbell appearance still persisting.

CONCLUSIONS

1. The cautious roentgenologist, on encountering a case showing the typical appearance of leather-bottle stomach, will do well to report his findings in detail, but reserve his final diagnosis, stating that the case may be one of three things:

(a) Syphilis of the stomach.
(b) Diffuse carcinoma of the stomach.
(c) Fibromatosis of the stomach wall.

2. The terms "linitis plastica" and "leather-bottle stomach" may well be retained as descriptive of this type of deformity of the stomach, but with a full appreciation of its triple nature.

DISCUSSION

Dr. A. F. Holding. In discussing this paper, we (Jackson Clinic) happen to have a case of linitis plastica hypertrophia chronica, and I thought I would show you the slides and trace the development of this case, which as far as I know is unique in that it has been under *x*-ray observation since its start. This case was examined first in December, 1919, and a filling defect demonstrated. I reported a "filling defect which was suspicious," and suggested a re-ray. Dr. James A. Jackson and I examined the patient together fluoroscopically. We got a perfect outline of the stomach, so we thought that the defect previously seen was due to spasm or to pressure of the spine, or something like that. There was no tumor palpable. The case was discharged with instructions to report at the end of three months. At the end of eight months, I found the case had gone to the University Clinic, and that they had made an *x*-ray examination. Dr. R. H. Jackson was asked for a surgical opinion, and we asked to see the plates. These plates showed a filling defect, constant, which we thought was carcinoma. At this time, there was a palpable epigastric tumor.

This shows the development of this case—eight months before we found first a filling defect, and then were able to exclude it—for by the administration of antispasmodics, we had a normal stomach shadow—no palpable tumor. Eight months later—large, typical, constant filling defect—palpable epigastric tumor.

The case was operated by Dr. R. H. Jackson, and a pylorectomy done. After taking the tumor out he said it cut rather "funny," that it showed a cheesy consistency, and did not cut like a typical carcinoma, that when he cut through it, it creaked like leather. So the specimen was sent to the Mayo Clinic, and they reported back a typical case of linitic plastica. Through the kindness of Dr. Broders, I have been able to obtain slides and photomicrograph of the case, which are here presented. I am indebted to Dr. Curl for the privilege of showing some of these plates.

Dr. L. T. LeWald. A question has been brought up which is still under discussion by pathologists. For example, Dr. Ewing, I believe, takes the stand that all linitis plastica cases are malignant, with the idea that they are carcinomatous, that if you search hard enough, you will find carcinoma cells. However, other pathologists do not agree with this, and among a series of sixty cases reported by Dr. Lyle, you will find statements like the following: "Linitis plastica, malignant type; linitis plastica, benign type," etc. Case I is running a course toward a fatal determination, but whether due to the gastric stenosis or to malignancy is not definitely known.

SELECTIVE ORGAN STIMULATION BY ROENTGEN RAYS: ENZYME MOBILIZATION

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AMONG the numerous biological phenomena which have been studied in connection with x-rays and other radiant agents, the effect on enzymes has received considerable attention. Usually such studies have been made by subjecting enzymes *in vitro* to rays of varying intensity. The opinion has been repeatedly expressed that intracellular enzyme activity must be altered following the raying of tissues, and a number of observations have been recorded which relate to this subject. Thus Heile[1] believed that the destruction of the leucocytes would liberate large amounts of proteolytic enzymes and that these liberated enzymes would then be able to attack other tissues. Neuberg,[2] who worked with the effect of radium on tumors, formulated his ideas in the following manner. The radiation causes a destruction of all the enzymes which have to do normally with the anabolic processes of the cell, while those that bring about autolysis are not altered. He showed that rayed carcinoma tissue autolyzed more rapidly *in vitro* than unrayed tissue. A number of other workers have reported experiments similar in character (Packard, Heile, Wohlgemuth, etc.).

So far no experiments have been reported which deal with the actual demonstration of alterations in the titer of the serum enzymes after x-ray or similar stimulation. Under the circumstances we thought it would be of interest to determine (a) whether such an alteration in titer does take place, (b) whether variations in the serum enzymes take place when different organs are stimulated, and (c) the influence of different degrees of stimulation on the alterations in titer.

In our experiments we have used dogs rather than the smaller laboratory animals. The larger serum amounts can be withdrawn from them for study without injury; the normal serum enzyme titers more closely resemble those obtained in the human, and in smaller animals the raying of organ groups is technically much more difficult and uncertain. Even in dogs it is of course impossible to confine the rays to any one organ, so that when the liver area is rayed, parts of the pancreas, the gastro-intestinal tract, etc., will necessarily be included to some extent and the results must be interpreted with this consideration in mind. In our preliminary experiments we used large doses (Coolidge tube, 10 inch distance from the skin, 8 ma., 5 to 8 inch back-spark without filter) for periods ranging from fifteen minutes to one hour. With the shorter periods of exposure we found that raying of the liver and intestinal areas resulted in some mobilization of enzymes, but that following the longer periods the titer of the enzymes diminished. We then proceeded with a filter (4 mm. aluminum) and reduced the time of exposure to the following periods—five minutes, ten minutes and twenty minutes, the latter with and without a filter. When so rayed, considerable alterations in the serum enzymes could be determined depending on the area rayed and on the duration of the exposure.

Our studies on the dogs included the nitrogen secretion, the non-coagulable nitrogen of the serum, the leucocyte and differential count, the coagulation time of the blood, the titer of the serum protease, peptidase, esterase (lipase), diastase, the anti-trypsin, and the complement titer. During the course of the experiments a number of dogs were used for each regional exposure, but in the accompanying chart the average for two dogs has been used.

Nitrogen Excretion.—The animals were kept in metabolism cages and on a fixed diet. With the exception of the periods following the longest liver exposures there was no apparent increase of nitrogen excretion following the *x*-ray periods in the course of the experiments. Following the twenty minute exposure of the liver area the average nitrogen excretion was, however, increased approximately 60 per cent for a period of four days following the exposure.

Non-coagulable nitrogen of the serum.—This was altered to a considerable extent only following raying of the liver area where an increase of as much as 50 per cent was occasionally determined after raying for ten minutes or more. This increase persisted for several days in such animals. Hall and Whipple[3] in their experiments with lethal *x*-ray doses obtained such increases with considerable regularity.

The Leucocyte Count.—The leucocytic reaction showed considerable differences with the different regions stimulated. In the following tabulation the normal count taken before the *x*-ray exposure is contrasted with the average of the counts obtained for the one-half hour, one hour, five hour, twenty-four hour, forty-eight hour and seventy-two hour periods:

CHART I

	Liver	*Spleen*	*Intestine*
Normal	4,000	10,000	3,000
After 5 min. Exposure	7,600	16,700	3,400
Before	3,200	14,200	3,000
After 10 min. Exposure	5,600	13,400	8,200
Before	3,400	11,400	7,400
After 20 min. Exposure	10,000	11,300	12,000
Before	4,800	13,700	14,300
After 20 min. Exposure (without filter)	8,100	14,300	17,450

In Chart I the effect of the raying on the leucocytes is graphically apparent. It will be observed that following the raying of the liver there resulted a leucocytosis of transient nature; following raying of the intestinal area the effect of raying was a step-like increase until a relatively high leucocytosis (15,000) was maintained. The two dogs used for the spleen experiment commenced with a relatively high leucocyte count (as well as a high serum enzyme titer) and raying did not materially alter the count. The commonly observed leucopenia that follows raying in the human was not observed in this series of animals with the doses that we employed.

Differential Count.—Following the raying of the hepatic area three of four dogs observed showed a well marked eosinophilia. This ranged from 5 per cent to 20 per cent and persisted for a number of days after the exposure. Raying of the intestinal area and the splenic area resulted in general in a diminution of the mononuclear elements and a relative increase in the polymorphonuclear cell forms.

Blood Coagulation.—A number of European observers have recently discussed the increase in coagulability of the blood which they have observed after raying of the spleen. Our observations were made with the capillary tube method and gave us a normal clotting time that varied between three and four minutes. Promptly following the raying of the animals this was usually reduced from one to two minutes, the blood clotting so rapidly that the bleeding of the animals was at times very difficult. In our series there seemed very little difference whether the splenic or hepatic or intestinal area was rayed, the result being apparent no matter what region was stimulated. In studies reported in the following paper it was found that an increase in the thromboplastic substance as well as an increase in fibrinogen occurred after the raying.

The Serum Enzymes Protease.—The proteolytic titer of the serum was estimated by the chloroform method which has been described elsewhere.[4] While open to objections, it nevertheless seems to give a fair index of the proteolytic capacity of the blood. As will be observed in the chart (the nitrogen digest of the serum is expressed in 1/10 milligrams), raying of the hepatic area increased the serum proteases after the ten minute exposure and the twenty minute exposure. The long exposure when unscreened was no longer effective. Protease appeared in the serum after raying the intestinal area, too, while raying the spleen seemed in general to be followed by a diminution of the originally high titer.

Peptidase.—Peptidase was titrated by allowing varying dilutions of serum to digest Witte peptone and determining the liberation of tryptophan by means of the simple bromine color reaction. Normal dog serum contains practically no peptidase; after raying the liver the enzyme makes its appearance but never to the extent that was observed after raying the intestinal area. Raying of the splenic area was never followed by such mobilization.

Lipase.—Serum esterase was determined by incubating ethyl butyrate with serum and titrating the resulting formation of acid by means of 1/50 NaOH. Moderate doses of *x*-rays seem to mobilize this enzyme after raying the hepatic as well as the intestinal area; raying of the splenic area, on the other hand, seemed to cause a gradual reduction in the amount of lipase in the serum. This was not, however, a constant finding in all of our animals, for in some raying of the spleen was at times followed by a well-marked mobilization of lipase, especially following a single dose of moderate intensity.

Serum Diastase.—The titer of the serum diastase was determined with the Wohlgemuth method of starch digestion by varying dilutions of serum, and the titer is expressed in units (24 hour digestion). Raying of the hepatic area was usually followed by a short sharp rise in the diastase curve. In the chart this does not become apparent because the average for the six bleedings after the *x*-ray exposure was not greatly altered. Raying of the intestinal area did not generally influence the titer, while raying of the splenic area was followed rather by a diminution.

Complement.—The complement titer (hemolytic titer) was followed in a number of animals, but seemed unaffected by the rays in the dosage that we employed. (Not charted.)

Anti-ferment.—Fluctuations in the titer of the serum anti-ferment were quite marked. As a rule the titer increased for a short time following the exposure, then diminished and gradually increased again for from forty-eight to seventy-two hours. The most marked effect followed the more intense periods exposure. (Not charted.)

DISCUSSION

While the clinical development of the *x*-ray and the related radiant agents has been confined largely to the field of diagnosis and local therapeusis, the possibility of remote therapeutic effect has not been uninteresting to medical observers. Among them Edsall and Pemberton[5] endeavored to utilize the effect of the *x*-ray in stimulating autolytic processes by their effort to hasten the autolysis of unresolved pneumonia by means of *x*-ray. Since their publications a number of observers have apparently sought similar applications. Perhaps the work of Manukhine[6] is of particular interest in this direction. Manukhine, aware of the influence that the spleen seems to have in favorably influencing the course of a tuberculous process, found that when he rayed the spleen of tuberculous animals (and patients) the tuberculous process improved. When, on the other hand, he rayed the liver the tuberculous process rapidly extended. He sought to explain the result because of the differences that follow in the leucocytic reaction with the different organs stimulated. While this is not to be excluded, we are nevertheless of the opinion that other factors must be taken into consideration, among them the effect of the serum enzymes which as we have shown in these studies takes place after *x*-ray stimulation.

Other observers besides Manukhine have

taken advantage of the remote effects of *x*-ray stimulation to bring about therapeutic effects. Drey and Losser[7] have but recently called attention to the effect of splenic *x*-ray stimulation on bronchial asthma, an effect first observed by Schilling;[8] Stettner[9] has used the stimulating property of *x*-rays in increasing healing and ossification and has also made the application in the stimulation of glands of internal secretion, as for instance in raying the head to stimulate the hypophysis to promote growth.[10] Stephan's[11] work in studying the effect of splenic raying on the blood coagulating mechanism will be discussed in the following paper.

The regional stimulation of the abdominal organs such as we have reported in this paper may perhaps be of some significance in the study of the intoxications brought about by *x*-rays and similar agents. Using small laboratory animals Denis, Martin and Aldrich[12] found that intoxication was dependent on exposure of some part of the gastro-intestinal tract and they are of the impression that the intoxication is closely concerned with a reduction of the alkali reserve found by them following raying of intestinal areas. Hall and Whipple[3] regard the intoxication as a protein intoxication following injury of the gastro-intestinal mucous membrane. If the effect is in the nature of a non-specific protein intoxication we must keep in mind that some of the remote therapeutic effects occasionally observed may be closely related to non-specific therapeutic results obtained by other means, such as vaccine, proteose, milk or tuberculine injections.

If pathological lesions are to some extent influenced by the serum enzymes it would seem to us possible that through *x*-ray organ stimulation or stimulation by other related agents a means of such therapeutic control is offered. We are of course at the present time unable to state definitely whether the metabolism of the normal cell is altered by the alteration in titer of serum enzymes; but where we deal with necrotic tissue it would seem plausible that an increase of the proteolytic serum enzymes would hasten the removal of such material provided that other factors that influence digestion (hydroxyl-hydrogen balance, anti-ferment concentration, etc.) are favorable. It might seem of interest to keep such enzyme mobilization in mind when studying the remote effects of radiant agents, not only where we have to deal with toxic manifestations (*x*-ray shock, etc.) but also where favorable therapeutic influences are made manifest.

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THE INFLUENCE OF X-RAY ORGAN STIMULATION ON THE COAGULATION MECHANISM

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DURING the experimental observations on the effect of the *x*-ray exposure of the hepatic, splenic and intestinal areas for varying periods of time as reported in the preceding paper, evidence of a change in the coagulation time of the blood was obtained. A number of recent investigators, observing the reduction of the coagulation time following the raying of the splenic area have suggested that measure for therapeutic use in cases of severe hemorrhage. Stephan[1] for instance reports a case of purpura fulminans in a man of forty-five in which a refractory hemorrhagic diathesis was successfully combated early in 1919 by means of deep roentgenotherapy applied to the spleen. Investigations that he undertook in connection with this result led him to state that roentgen radiation applied to the spleen rapidly decreases the coagulation time of the blood *in vitro,* and increases likewise to a considerable extent the amount of coagulating ferment in the blood serum. Radiation seems to have the same effect on the organism as extensive loss of blood. The essential factor that arrested and cured the hemorrhagic tendency was the increase in the quantity of the coagulating ferment, and this was realized by the action of the roentgen rays on the spleen. He thinks they exert a specific functional stimulus on the elements of the spleen other than the lymph follicles. The blood platelet count does not seem to be modified. The coagulation time was shortened sometimes to one fourth even in normal subjects by raying the spleen; the maximum effect was apparent between the second and fourth hours, and then gradually subsided. His clinical and experimental research demonstrated, he believes, that stimulating the functioning of the spleen by roentgen radiant energy must be regarded as theoretically a true physiologic method of arresting venous and parenchymatous hemorrhages. In numerous cases it proved extraordinarily effectual in practice, far surpassing the effect of any medical hemostatics.

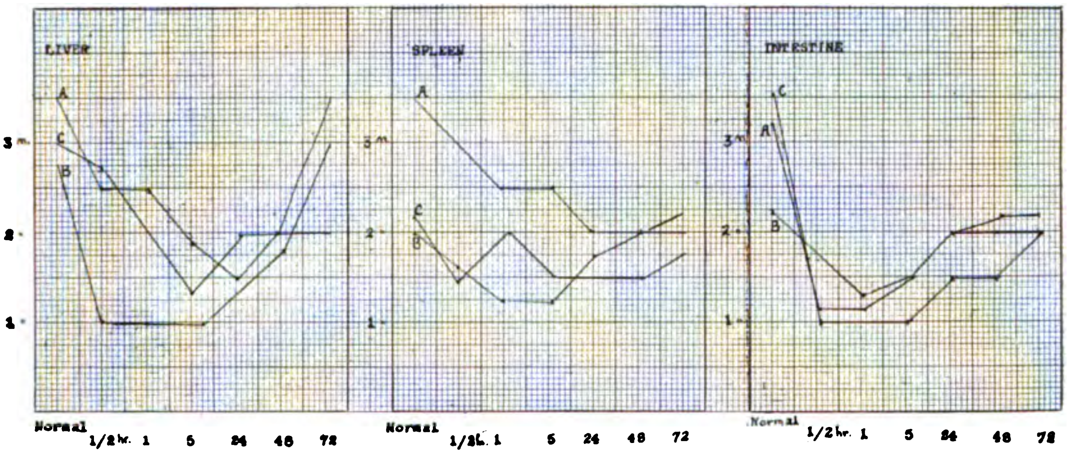

CHART I. COAGULATION TIME OF THE BLOOD AFTER X-RAY EXPOSURE FOR FIVE, TEN AND TWENTY MINUTES.

Jurasz[2] considers this observation of considerable practical importance in surgery, and recommends that before operative procedures the coagulation time of the patient be determined, and if it is found delayed, that the patient be rayed from fifteen to twenty hours before the operation in order that the coagulation time be brought within normal limits.

As a matter of fact it is probable that any stimulation of the spleen results in this same effect on coagulation. Thus Nonnenbruch and Szyszka[3] found that simple diathermy of the splenic area would appreciably increase the coagulability of the blood in from one to two hours. The effect was, of course, not quite so pronounced as following radiation. Szenes[4] found that the increase in coagulation occurred not only after raying the spleen, but after raying lymphatic tissues in general.

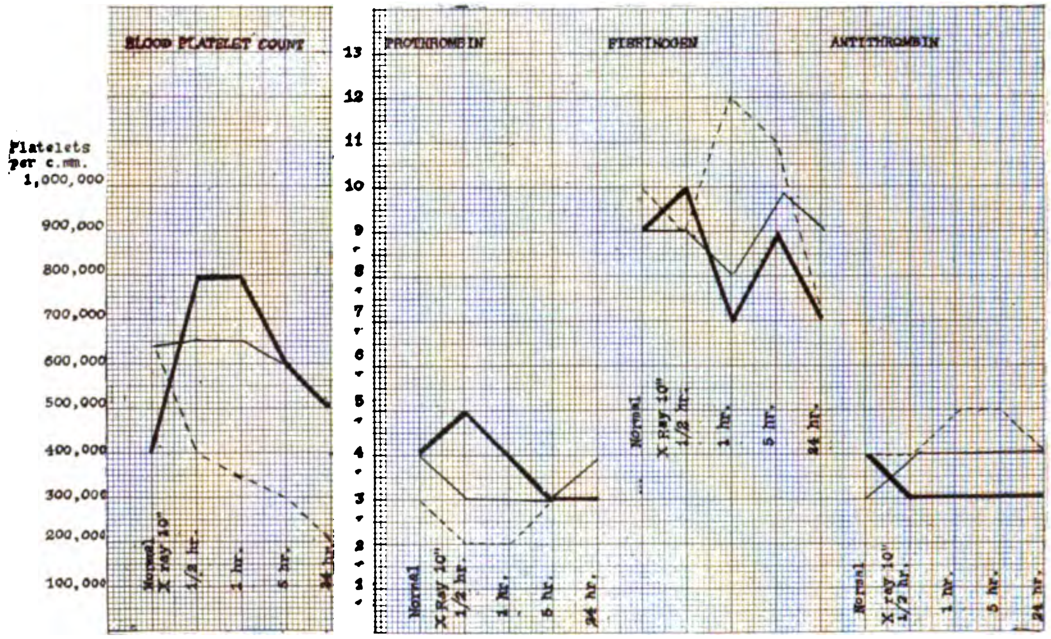

CHART II. HEAVY LINE—Titer after raying hepatic area; DOTTED LINE—Intestinal area; LIGHT LINE—Splenic area.

In a more recent publication Stephan[5] takes exception to the work of Szenes, however, for the reason that his observations were limited wholly to the measuring of the coagulation time, not to a study of the individual factors in the coagulation balance. Thus a lowering of the antithrombin content, or an increase in the platelet count might simulate the results obtained when there is an actual increase in the thrombin.

In view of the practical importance of the subject we have made a detailed study of the alterations that occur in the coagulation mechanism following raying of the hepatic intestinal and splenic area. The observations included the following: clotting time; prothrombin; antithrombin; fibrinogen; blood platelets.

Prothrombin and antithrombin determinations were performed according to the method of Minot.[6] Thrombin was prepared according to Howell.[7] Fibrinogen determinations were recorded according to Wohlgemuth.[8] Blood platelet counts were observed by the Wright-Kinnicut method.

Dogs were exposed for 10 minutes (Coolidge tube, screened by a 4 mm. aluminum screen, at 10 inch distance, 8 ma. and 5 inch back-spark) over the liver, intestinal and splenic areas. The exposures were made in the morning (serum samples being obtained before) one-half, one, five and twenty-four hours after exposure.

BLOOD COAGULATION.—In studying the coagulation time, capillary tubes drawn out to a uniform diameter were used, the clotting

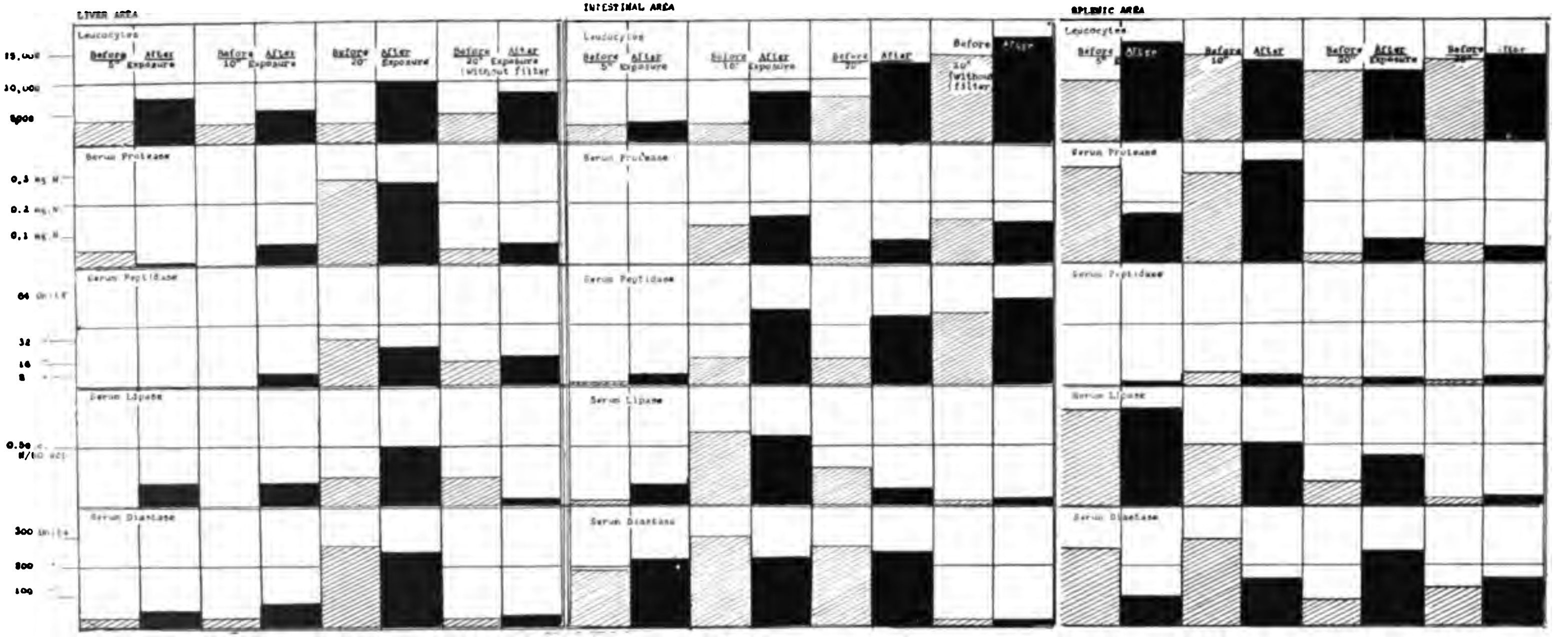

Chart III. Illustrating leucocytic and enzymatic reaction following raying of liver, intestinal and splenic areas in dogs for five, ten and twenty minute periods. The shaded blocks represent the titer before the period of raying, the black blocks the average for the determinations following the raying (serum samples taken ½, 1, 5, 24, 48 and 72 hours after the exposures).

time recorded when on breaking the tube a firm coagulum could be drawn out. In our experiments the most prompt effect on the clotting time seemed to follow raying of the lower intestinal tract; the effect on the clotting time following exposure of the splenic area was more delayed. In the later case, however, the effect on the coagulation especially after longer raying periods was more prolonged. In Chart I the average coagulation time is shown.

In view of the rather decided changes in the coagulation time above noted we anticipated marked alterations in the titers of the coagulating factors in the blood, corresponding to the observations of Stephan. In this we were disappointed. As will be observed in the next chart (Chart II) fluctuations in the various elements of the balance did occur but not to the extent demanded by the marked lowering of the actual coagulation time.

BLOOD PLATELETS.—Raying of the hepatic area gave a maximum increase of blood platelets during the one half to one hour period, gradually returning to normal. Raying of the splenic and intestinal areas gave a gradual diminution in the platelet count during the ensuing time periods.

PROTHROMBIN.—Exposure of the liver showed a slight decrease up to the one-half hour sera, with gradual increase in the remaining sera, while the spleen and intestinal exposures showed an increase with a subsequent return to normal. (The curve, Chart II, in which the serum dilutions are charted, represents the inverse of the actual titer of the prothrombin present in the serum. Thus the actual amount following hepatic raying after a slight diminution, was increased, as was also the case after raying the splenic and intestinal areas.)

ANTITHROMBIN.—Raying the intestines showed a maximum increase during the one to five hour periods; splenic raying showed a slight increase through to the twenty-four hour sample, while raying of the hepatic area showed a miximum increase during the one

FIBRINOGEN.—The maximum increase in fibrinogen from intestinal raying was noted in the one and five hour period, diminishing to below normal in twenty-four hours. The splenic raying was followed by a decrease with a maximum increase at the five hour period, returning to normal at the twenty-four hour period. Liver raying showed transitory increase with fluctuating decrease and increase to below normal as noted in Chart II.

CONCLUSIONS

1. Raying of the splenic area in dogs is followed by a diminution in the clotting time of blood determined by the capillary tube method.

2. Raying of other areas (hepatic and intestinal) is also followed by similar changes in the clotting time. The mechanism of the alterations in clotting time may differ following various regional exposure. Thus raying of the splenic area was followed by an increase in prothrombin, some increase in antithrombin, a rather delayed increase in fibrinogen, with little alteration of the platelet count. Raying of the hepatic area was followed by a rather considerable increase in platelet count; raying of the intestinal area by an increase in the amount of fibrinogen.

3. Inasmuch as the effect of the x-ray exposure is quite prompt the use of this measure in surgical cases as well as in the management of medical cases associated with a hemorrhagic diathesis seems a feasible procedure. The clinical success of the x-ray in the treatment of uterine hemorrhage may depend in part on the general effect on the coagulation mechanism.

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AN X-RAY BURN OF THIRD DEGREE FOLLOWED BY RAPID HEALING*

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AN UNUSUAL case of rapid healing of an extensive *x*-ray burn seems of sufficient interest to *x*-ray therapeutists to warrant its formal presentation in detail. Lest the surprising occurrences hereinafter described be doubted by those whose *x*-ray experiences have brought them into contact with similar reactions of unwished for degree with less favorable results, photographic evidence is offered as part of the record.

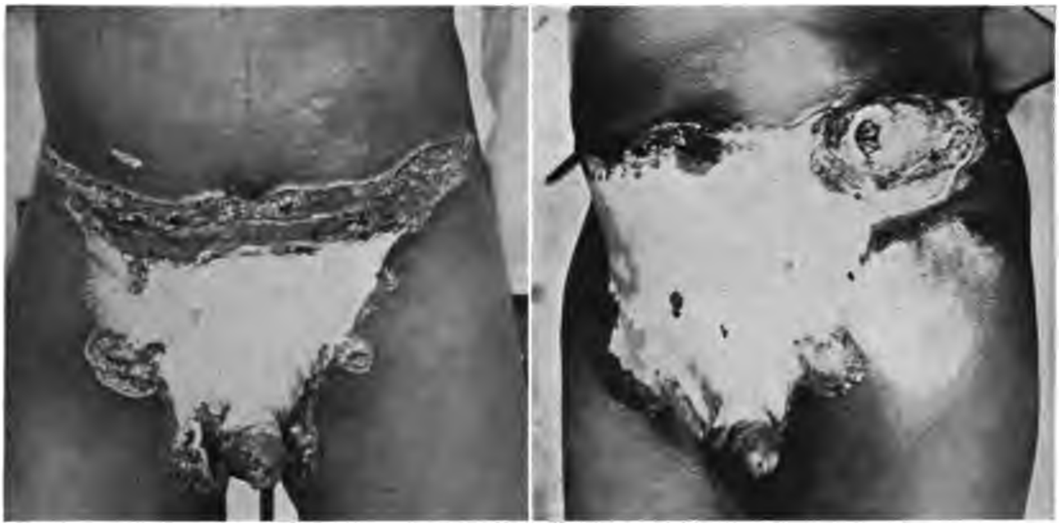

FIG. 1. FIG. 2.

Experience in *x*-ray therapy in skin diseases teaches that the first degree reaction is often necessary to bring about a cure in many conditions; it is usually a transitory condition, a reddening or blushing, which soon fades, the skin returning to normal. Occasionally a second degree reaction occurs, in cases in which a first degree change was desired. This often follows an overdose through misjudging the patient's resistance to *x*-ray action. Depending on the size of area involved and the individual's resistance, this superficial skin destruction will be followed by healing which takes several weeks (sometimes months) and disappears, leaving little or no scarring. In some cases such reactions become a serious consideration to the therapist if the healing process be unusually slow. Through accident, an overdose may be so severe as to result in a third degree reaction or burn. This third degree reaction is a far more serious event than the preceding and most often results in a train of developments which gives the *x*-ray therapist immeasurable worry and often mental anguish, as there is so little that one can do for the relief of the condition. The degree of skin and underlying tissue destruction is so great that some such cases will never heal and recourse to skin grafting is necessary. The tissue destruction may extend through the deeper muscles and reach the underlying bone or even go entirely through a part.

An exception to the usual course of events in a third degree *x*-ray burn occurred in a case which was being treated for a very extensive blastomycosis of the lower abdomen.

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*Read by title at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn. Sept. 14-17, 1920

The patient was a colored male, thirty-seven years of age. He was in good physical condition except for an extensive blastomycotic skin lesion. This lesion was of ten years' duration and began as a small "pimple" on the skin at the perineum. It was of very slow growth and gradually spread in anterior and posterior directions, reaching the posterior limit of the median groove between the nates but not spreading over the buttocks; its greatest spread occurred anteriorly from the point of origin over the entire scrotum, over the shaft of the penis, the glans, and it then invaded the skin over the lower abdomen by way of both inguinal folds, spreading about equally on both sides of the body to the flanks at the regions over the iliac crests. (Fig. 1.)

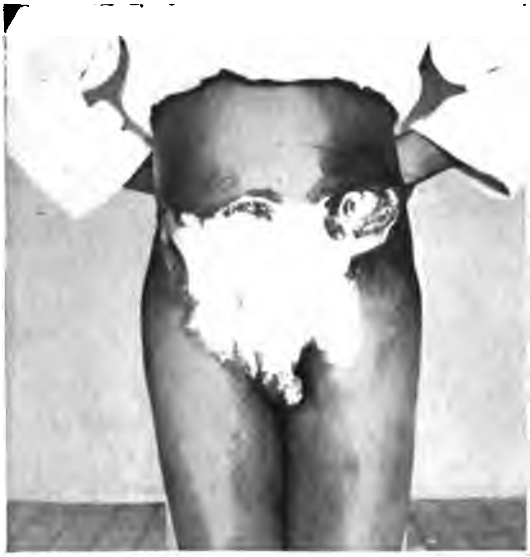

Fig. 3.

In the ten years of growth the patient had knocked around from doctor to doctor and clinic to clinic but obtained no permanent relief. The lesion continued to spread slowly in spite of all efforts to arrest its progress. He was unable to work and became a public charge. As is characteristic of this fungus invasion of the skin, the edges of the lesion only were the site of the activity; the remaining area already run over by the growth was left a leathery tough hard skin in which all skin pigment peculiar to the colored race was lost and he was seemingly turning a pinkish white. In the zone of activity the lesion itself had much of a cauliflower appearance. This zone was from 4 to 5 cm. in width all along the edges of the involved area.

X-ray therapy was advised by the late Dr. Harris (at that time head of the skin department of the Cook County Hospital) and treatment was begun in September, 1916. In view of the marked chronicity of the lesion and failure of all other therapy to effect a cure, a more than ordinary skin dosage seemed to be indicated. Multiple areas were necessary to cover all the lesion present. The normal skin was protected from the exposure and three circular areas over lower abdomen anteriorly and one over the perineum were radiated, four in all, each three inches in diameter. A formula of 5 milliamperes of current, a 5 inch spark-gap resistance (60,000 volts), at a 7 inch target to skin distance, for five minutes, with 2 milliammeters of aluminum filter, was given. No noticeable changes followed the first treatment. A second dose was given ten days later which was followed in about a week by a noticeable improvement.

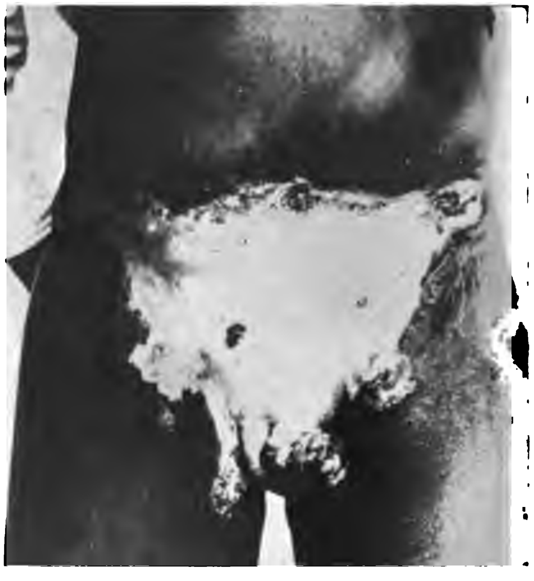

Fig. 4.

Subsequent treatments were given at two weeks' intervals and the lesion continued to improve. After the fifth series the condition was practically healed with but a few spots of activity remaining, which required more treatment. The patient naturally was much pleased at the outcome and relief from his condition. He informed me with much joy that he now, for the first time in ten years was able properly to use toilet paper.

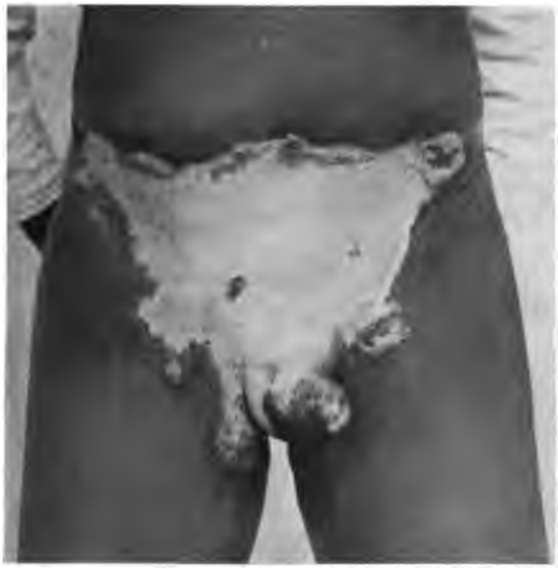

Fig. 5.

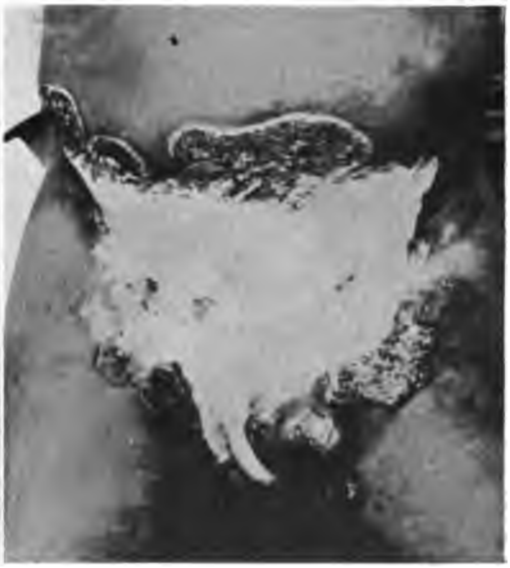

Fig. 6.

At this time an enforced absence necessitated that the treatments be given by an assistant whose previous work had been satisfactory. Explicit instructions called for radiating three areas over the abdomen from right to left and the formula to be followed exactly as already described. Area No. 1 was to be given on the right side anteriorly; area No. 2 in the median line anteriorly and No. 3 to be on the left side also anteriorly. Owing to a slip-up in this proceeding, area No. 1 was given which was followed by area No. 2. Then, instead of setting the x-ray tube over area No. 3, the No. 1 area was given a second full dose under the impression that this was the area remaining to be treated. Of course this was not recognized at the time.

In a very short time, the second or third day following, a complete tissue break down rapidly developed in area No. 1, and in eleven days the entire abdominal wall, the skin, subcutaneous and muscle tissues, in the exact area treated, about 3 inches in diameter, had disappeared down to the peritoneum. This alarming event naturally caused much concern. The coils of the intestines could be seen through the thin peritoneum which appeared as a more or less transparent veil. Why this thin structure did not also break down is not explained. The patient did not complain of much pain and seemed the least worried of those concerned. We cautioned all those in his ward not to startle him or in any wise cause any sudden muscular action, for it was feared that the thin wall remaining might rupture, through sneezing or other similar violent movement and thus call for an emergency operation to replace some popped-out colon. He was kept very quiet and a sterile dressing kept in place over the eroded area, binding it firmly and very tightly over the hole in the belly wall. We held our breath, prayed much and feared more, slept but little and went about in fear and trembling. No medication of any kind was given and plans were made for a later surgical repair, if possible. (Fig. 2.)

In fifteen days the broken down tissue had increased but very slightly in extent. (Fig. 3.) During the next few days a surprising change took place and in one week one hardly recognized the area. The edges had filled in apparently with new regrown tissue, the hole had closed and its size was now about one third of the original area. With wonder we daily observed its progress. We had of course discontinued all *x*-ray treatment to the small, still active spots which consequently began to spread. In thirty days (Fig. 4) the burn had made further healing progress, had become noticeably smaller and in thirty-nine days (Fig. 5) no definite evidence of the accident was visible. There was no real scar, and but little puckering or drawing in of the healed-over spot.

The remaining areas of revived blastomycotic growth were subsequently treated by *x*-ray dosage of the same formula as given above, and a complete cure was obtained. No untoward sequelae have occurred since the events here described (three years) and the patient is now working.

Seeking for an explanation of this unusual healing of so marked a tissue destruction, it has been suggested that the area involved was no longer true skin tissue, having been changed by the fungus invasion, and that therefore it responded in a different way from that in which the normal skin responds.

HIRSCHSPRUNG'S DISEASE. REPORT OF CASE

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HISTORY.—Miss F. B., age eight, was admitted to the hospital with the following history. Father is a syphilitic, and mother is now in a sanitarium with active tuberculosis. Patient normal at birth according to mother's statement. At the age of seven months began to have attacks of constipation, which attacks would last for several days at a time. Her parents then observed that patient's abdomen had begun to distend, and for the following three years had only two stools a week. During one prolonged attack of constipation, patient went into a state of coma, which lasted three days. During this time she had involuntary liquid stools. Drastic cathartics were administered and patient regained consciousness. For the past three years child has been given prune juice and various fruits in addition to her regular diet, which has regulated her bowel action fairly well. Recently, however, the attacks of constipation have become more severe, lasting from a week to ten days. She complains of nausea at times, but does not vomit. Patient has no desire to play or exert herself in any way, as it tends to bring on cardiac distress. She has not lost any weight. She appears to be intelligent, and keeps up well with her schoolmates in her studies.

Examination.—On routine examination, child was found to be normal except for the abdomen. The abdomen was uniformly distended. A palpable mass could be indistinctly outlined on the left side. The patient did not complain of any pain or distress at the time of examination. She was put to bed and an attempt made to clean out the intestinal tract. Quantities of fecal matter were passed following the administration of cathartics and enemas. On the fourth day the patient was sent to the *x*-ray department.

Roentgen Findings.—Screen examination. Under the fluoroscope the stomach appeared to be somewhat distended for a child of this age. Peristalsis was very inactive. No filling defects were noted. The cap was visualized. The duodenum appeared to be distended with gas.

Plate Examination.—Plates made soon after the ingestion of the meal showed findings similar to those noted above. Six hour plates showed considerable gastric residue, only a small portion of the meal having passed into the small intestine, which was crowded over to the left of the median line. (Fig. 1.) Twenty-four hour plates disclosed a large residue in the cecum, the ascending and transverse portions of the colon being well outlined. The transverse colon was deep in the pelvis. Plates made at the termination of twenty-four hours showed a small amount of barium in the cecum and transverse colon. One week later patient was again fluoroscoped, and a small cecal retention was observed. She was put to bed and given daily cathartics and enemas. At the end of ten days, she was given a barium enema composed of 1000 c.c. of water, and 180 grams of barium. This was retained without difficulty. Plates made showed the sigmoid and descending colon to be greatly distended, forming a pouch-like mass which filled the greater part of the pelvis and left abdomen. (Fig. 2.)

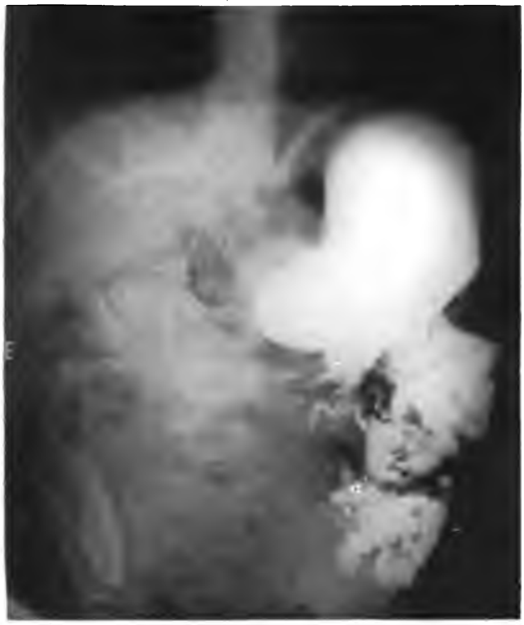

FIG. 1. SIX-HOUR GASTRIC RESIDUE. Small intestine crowded over to the left of the median line.

For two days following the administration of the barium enema, patient passed quantities of fecal matter and barium. Repeated fluoroscopic examinations continued to show the presence of barium in the cecum, ascending colon and sigmoid. One week later the patient was again fluoroscoped and a small cecal retention was observed.

Diagnosis.—On the roentgen findings and history of the case a diagnosis of Hirschsprung's disease was made.

Operation and Results.—After three days of careful preparation, the case was referred to the service of Dr. Rexwald Brown for operation. Through a left rectus incision, a greatly dilated and thickened descending colon and sigmoid were delivered. Owing to the fact that the dilatation extended into the rectum it was found impossible to perform an end-to-end anastomosis. The distal third of the descending colon, together with the sigmoid and proximal end of the rectum, was resected. This portion of the intestine contained approximately two quarts of liquid feces. The colon and rectum were closed by infolding, and a lateral anastomosis made between the two free ends by means of an oblong Murphy button.

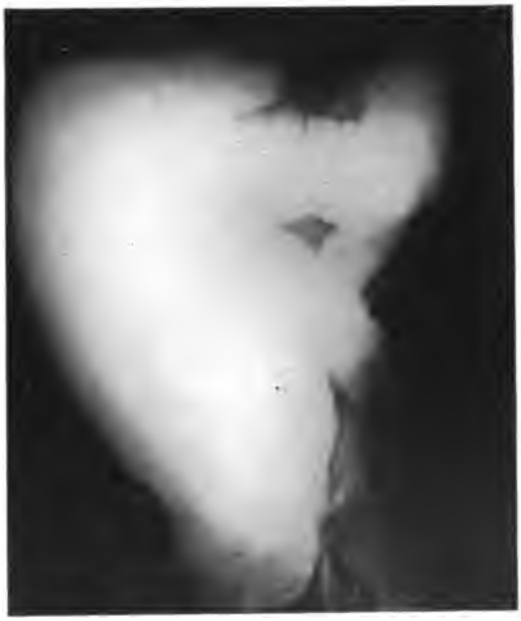

FIG. 2. ENORMOUSLY DILATED RECTUM, SIGMOID, AND DESCENDING COLON.

The patient's condition following the operation, and for the first week was excellent, and every hope was held for an uneventful recovery, but on the ninth day she suddenly developed an acute peritonitis. Drainage was of no avail, and the patient expired.

THE DIAGNOSIS OF A BRAIN TUMOR BY PNEUMOVENTRICULOGRAPHY

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In any large clinic a frequent subject of consultation between the surgeon and the roentgenologist is the question of the existence or the location of a brain tumor.

In only a very small percentage of tumors does the growth cast a shadow on the plate —Dandy in his studies of the subject says 6 per cent. These were tumors with definite calcified areas, and naturally only the calcified portions were visible. Other growths arising from the intracranial structures, being of no greater density than the surrounding tissues, were of course invisible by the ordinary methods of examination. The signs of intracranial tumors so well studied and ably described by other writers are in many cases pathognomonic, but the percentage is still less than one half and the location of the lesion is seldom definite.

Inspired by the work of Dandy we have made an effort in this clinic to follow his technique in a few cases. Our study has been limited to three cases, one child and two adults. In the first case the results were so striking that it seems worthy of report.

A white boy of six years with unimportant previous and family histories exhibited symptoms three years ago which were diagnosed clinically as probable brain tumor, but the roentgenograms gave no evidence and the lesion was never localized. Subsequent course bore out the diagnosis and two years ago an occipital decompression was done with some temporary relief.

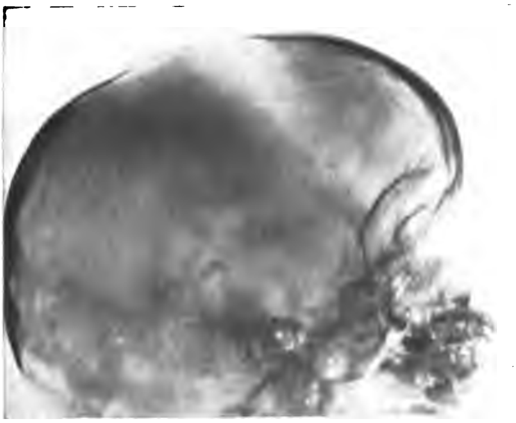


FIG. 1. CASE I. BEFORE INJECTION, SHOWING CALCIFIED AREA.

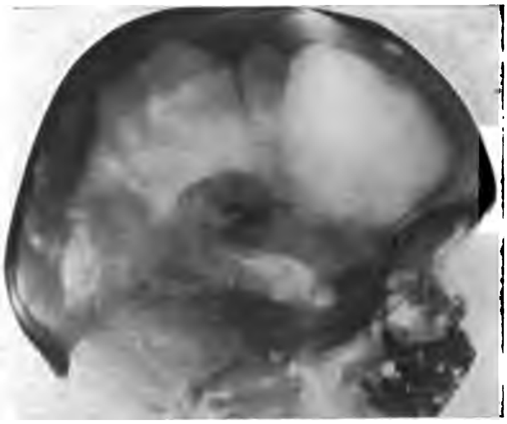


FIG. 2. CASE I. AFTER INJECTION, SHOWING TUMOR SURROUNDING CALCIFIED AREA.

He came to us in an apparently hopeless condition. Radiograms were made in the usual positions. The skull was seen to be unusually large and thin. Mottling of the inner table and changes in the base suggested intracranial pressure. The sutures were wide in the upper portion. Just above the mastoid shadow in the mid-portion of the skull was seen a calcified area of a horseshoe shape apparently in the brain.

With the remote hope of locating an operable lesion the surgeons considered pneumoventriculography. Through a small trephine opening the anterior horn of the right ventricle was entered. A large amount of fluid was released and air was allowed to enter under atmospheric pressure. Radiograms were taken in various positions. The tumor was distinctly seen surrounding the previously observed area of calcification and apparently occupying the site of the pineal body. From its size and location and the poor condition of the patient it was considered inoperable.

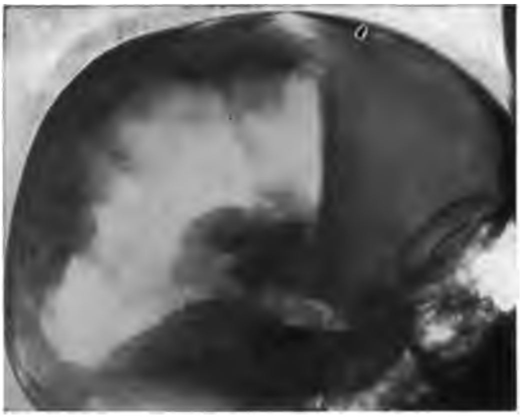


Fig. 3. Case I. Prone, showing Tumor and Fluid Level.

Following the operation the patient's condition grew worse and on the second day after he died.

It is the surgical opinion that the sudden release of so much fluid and great decrease of intracranial pressure may have hastened the course, although the patient was practically in extremis at the time of the operation.

Although the examination failed to help this patient or postpone the inevitable, it demonstrates several valuable points. It shows that intracranial tumors may be made visible. It leads us to believe that in similar cases the examination should be made earlier before the intracranial changes are so advanced. It suggests that where much fluid or great pressure is suspected a measure should be made as accurately as possible of the pressure and the amount of fluid withdrawn, and this restored by an equal amount of gas under an equal pressure.

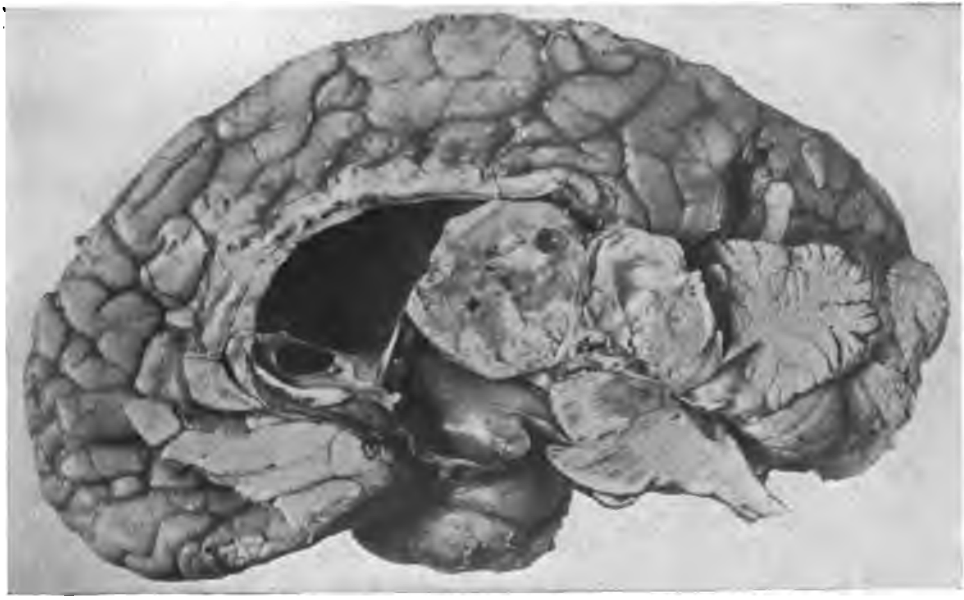
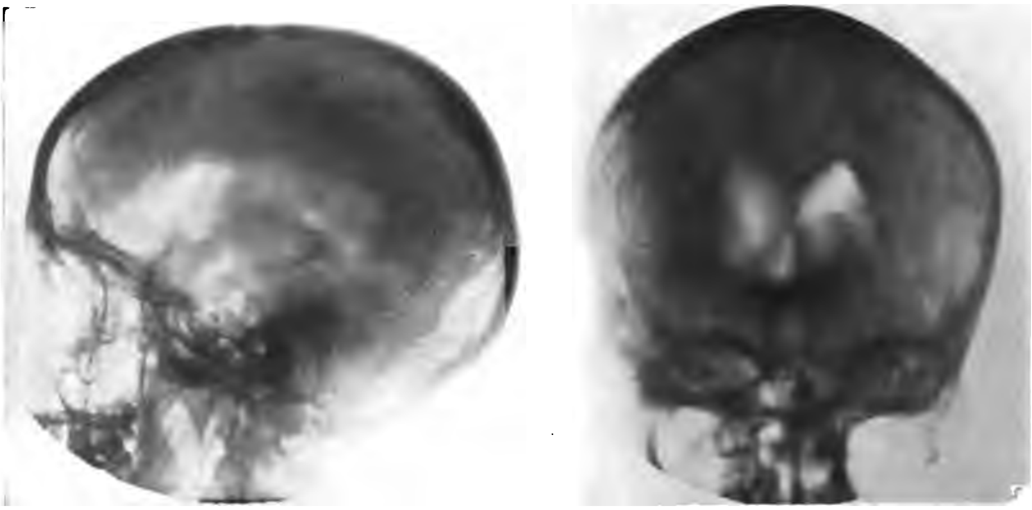


Fig. 4. Case I. Photograph of Right Hemisphere showing Section of Tumor.

At autopsy the tumor was demonstrated identical with the shadow in the plates and was found to be a teratoma originating apparently in the pineal body, and containing bone, hair and skin elements. The foramen of Monroe and the aqueduct of Sylvius were blocked by the tumor.



FIGS. 5A AND 5B. CASE II. VENTRICLES PRACTICALLY NORMAL IN SIZE. LATERAL AND THIRD VENTRICLES FAIRLY WELL SEEN. POSSIBLE MASS ON LEFT.

The other two cases were adults. In neither case were the findings conclusive. In one the ventricle failed to be injected. In the other there were suggestions of an abnormal mass, but we found ourselves handicapped by our unfamiliarity with the normal intracranial picture. This case complained of some headache for a few hours, but there were no disturbing symptoms in either case. These cases suggest to us that the operation may be done in selected cases without harm to the patient. We should make ourselves familiar with the normal picture by experiments on the cadaver before we can speak with certainty of small lesions.

The accompanying prints need little explanation.

FOREIGN BODY IN THE BRONCHUS FOR FIFTEEN YEARS

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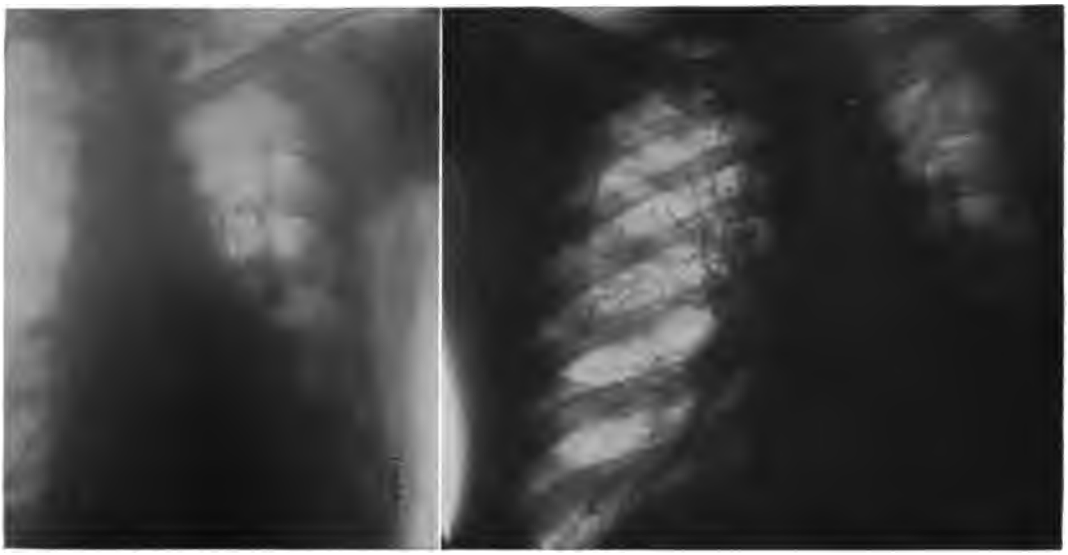
AS illustrative of the relative tolerance of the bronchi to metallic foreign bodies, so strikingly in contrast to the almost immediate reaction which follows the entry of vegetable foreign bodies, because of the tendency of the latter to disintegration and migration (Bégin has called this class of foreign bodies "progressors") the following case is reported:



FIGS. 1 AND 2. PL. A. NO. 220543; SERIAL NO. 70543, JULY, 1920. COIN (DIME) IN LEFT BRONCHUS. DESTRUCTION AND ATELECTASIS OF LEFT UPPER LOBE, FIBROSIS AND ATELECTASIS OF LEFT LOWER LOBE.

M. G., aged forty-five, entered Bellevue Hospital because of hemoptysis. The following history was obtained: Fifteen years ago he was holding a dime in his mouth and someone slapped him on the back and he felt the coin go down. He thought he swallowed it. He coughed for about ten minutes after this, trying to get the foreign body up but without avail. He was not short of breath and went about his work as usual, though for six months following the accident he could feel something "moving up and down" in his chest. During this time he coughed but very slightly. From that time, however, until six months ago he has been practically free of symptoms, with the exception of a very slight cough. There was no shortness of breath, no purulent expectoration. Six months ago he coughed up a considerable quantity of bright red blood. After this he again felt the sensation of something "moving up and down" in his wind pipe for two weeks. During this time the coughing was very severe and he had considerable expectoration with it. The symptoms abated and he was practically well until two weeks ago, when severe hemorrhage brought him to the hospital. From the clinical signs the diagnosis of fluid at the base of the left lung, with fibrosis of the upper portion of the left lung, a possible cavity and a possible aneurysmal dilatation of the aorta was made. Sputum showed presence of fungus but no tubercular bacilli.

The radiographic examination shows an almost complete excavation and atelectasis of the upper lobe of the left lung, with fibrosis and atelectasis of the lower lobe. The heart and mediastinal contents were retracted to the left. The trachea, however, was slightly deviated to the right. The opposite lung showed extensive compensatory emphysema. Between the seventh and eighth ribs, posteriorly, just to the left of the median line, was the shadow of a disc-like metallic body (the coin), its rounded edges somewhat roughened (due to calcarious deposit). The lateral view of the chest showed the coin located posteriorly in the main bronchus of the left lung, and lying in a plane parallel to the sagittal plane of the chest. The esophagus was normal.

That metallic foreign substances are tolerated in the bronchi without severe symptoms is well known in the literature. Such foreign bodies as nails (Collard), coins (Mitchel, Baldwin, Dupuytren), pins and pieces of bone have been found in the trachea and bronchi, where they had been for years without giving severe symptoms. Burch and Lake cite thirty-one cases in which foreign bodies were present in the trachea or bronchi in intervals of one year to sixty, in all of which recovery took place after expulsion or removal. In a case reported by Dupuytren a ten sol piece remained in the bronchus for ten years.

The pathogenesis of the lung lesion is usually the following: bronchitis, bronchopneumonia (peribronchial infiltration), multiple abscess formation, coalescence of the foci with the formation of a large cavity. With this there is fibrosis both of lung and pleura. These lesions were present in the case reported.

The foreign bodies remaining in the bronchi and trachea for a long time become covered with calcareous concretion. Several such cases in which foreign bodies were expelled after a long period, in calcareous form, have been collected by Aronssohn. He cites one case in which a cherry pit in the right bronchus was expelled a year after its inhalation, surrounded by a layer of phosphate of lime, one inch in thickness. (Hirsch, Foreign Bodies in the Alimentary and Respiratory Tracts, *Am. J. Surg.*, January and February, 1913.)

Hemoptysis appears to be a symptom present in the vast majority of such cases. Such recurrent hemorrhages may be the only symptoms for a long period. In many cases, sometimes in spite of a definite history, it is usually ascribed to tuberculosis.

It is difficult to understand how, in these days of abundant roentgen examinations. any foreign body in the respiratory tract can lie undiscovered for any length of time. The paucity of symptoms in a certain class of cases, of which the case reported is an example, may perhaps account for this. But nevertheless cases are being continually encountered in which, in spite of a characteristic history and distinct symptoms, the foreign body has been permitted to remain in the respiratory tract until irretrievable damage has been done to the lung and the removal of the foreign body, even by the skillful bronchoscopist, is no longer a simple matter.

The almost uncanny dexterity with which men like Chevalier Jackson remove the offending bodies from the inner and most submerged provinces of the lung makes one feel that the life of Pope Adrian IV, who died of a fly in his bronchus, would have been saved if Jackson had lived in Rome in the days of that august personality.

During the removal of the foreign body (a ten cent piece, partially encrusted) in the case reported, severe hemorrhages occurred. from which the patient died.

X-RAY FINDINGS IN THE CHRONIC GAS CASES * †

By HENRY C. PILLSBURY, M.D.

WASHINGTON, D. C.

THE close of the war and the return of our troops from France find scattered throughout the country many men who have been subjected to the action of irritant gas at some time during their service. These men will soon return to their civil status, and from time to time will appear at the *x*-ray clinics for the diagnosis of lung conditions. It is confidently expected that no man will be discharged, and later leave the care of the Public Health Service, who stands in need of any further medical treatment for the condition that was caused by his service; but these "gassed cases" will carry with them for a long time the scars caused by the irritant effect of the gas. Unless pathology of this condition is thoroughly understood, erroneous diagnoses may be made, and undue importance may be attached to the various thickenings of the bronchi seen.

Especially must the clinician be on his guard against the diagnosis of tuberculosis in these cases. It is not considered likely that any roentgenologist would make this mistake, as the appearance of the plate is entirely different in the two cases.

The gases that leave behind them a chronic change in the lungs are chlorine, chloropicrine, and especially phosgene. Contrary to the usually accepted opinion, mustard gas is practically without effect on the lungs. In this connection, care must be taken with the history. Nearly always the patient will state that he was gassed by mustard, when in point of fact he had no idea whatever with what gas he was affected. The several gases were used together to a certain extent. Further mustard causes such severe external burns that its action is most impressive. It is an easy name to remember, and in a great majority of cases soldiers will give the history of gassing by mustard quite confidently, although they may have actually inhaled phosgene.

The Research Division of the Chemical Warfare Service has done invaluable work on the pathology caused by the different gases. The description given below is taken almost entirely from their monographs. It is regretted that the masterly and scientific descriptions should be so garbled as has been inevitably the case, in the effort to present the condition as briefly as is consistent with reasonable clearness.

The pathology in the lungs caused by these gases is similar, but presents certain points of difference. Chlorine damages especially the upper respiratory tract, the trachea and the larger bronchi. This gas is a powerful irritant, and strikes that portion of the lung with which it first comes in contact. There is rapid and complete coagulation of the mucous surface; later, after recovery, the epithelium is restored, and the trachea returns to normal, except for the deposition of scar tissue. Rarely the injury may extend to the distal alveoli, causing desquamation of the alveolar epithelium and focal areas of necrosis.

Chloropicrine injures the epithelium of the trachea and larger bronchi, as does chlorine, but to a lesser degree. With this gas, the most notable effect is seen on the medium and smaller sized bronchi. When the bronchiolar wall has been seriously damaged, an active proliferation of fibroblasts occurs, and the bronchial cavity becomes filled with granulation tissue; the final result is an obliterative bronchiolitis, with its consequent atelectasis or localized emphysema. The same result may also occur as a consequence of occlusion of the smaller bronchi by inflammatory exudate, or by masses of necrotic cells. There is regeneration of the epithelium of the bronchi and alveoli, and organization of the necrotic bronchiolar wall, with scar formation. Focal atelectasis and emphysematous patches may remain.

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*Published with permission of the Surgeon General, U. S. Army, who is not responsible for any opinion expressed or conclusions reached herein. Board of Publications, Mary Pearson McKnight, Contract Surgeon, U. S. A. Secretary.

†Thesis presented on application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

Phosgene, the most important of all the gases used, in so far as the effect on the lungs is concerned, acts chiefly on the lining epithelium of the smaller bronchi and bronchioles. The upper respiratory air passages escape almost entirely. This gas as it is inhaled has no irritant properties. When, however, the gas reaches the moisture-laden smaller air passages, it is broken up, and HCl evolved. The lining epithelium is destroyed; later the epithelium regenerates, but there is a growth of granulation tissue in the walls of the finer bronchi which causes a thickening of its wall and a peribronchitis. In fact, the outstanding features of the later stages of this condition are the thickening of the walls of the bronchi, and the peri-bronchitis. In a certain number of cases this process goes further, and we find that the infiltration of the walls has extended to the point that the bronchus is entirely occluded. When this occurs, localized atelectasis and restricted areas of emphysema may be expected to be found.

Summarizing the action of the three most important gases, we find, therefore, that chlorine, the most irritant, affects the lining epithelium of the parts with which it first comes in contact—the trachea and larger bronchi. Chloropicrin, which must be broken up into a residue and HCl, only becomes effective after it has reached a part of the lung where moisture can be found—the medium sized and smaller bronchi. Here it causes the same lesions as chlorine. Phosgene is a little more stable than chloropicrin, and is only broken up into HCl and its residue in the smaller bronchioles and alveoli. It is here that it has its effect. It need not be supposed that these three gases are strictly limited in their action to the parts of the lung described; a massive dose or prolonged exposure of phosgene or chloropicrine will affect the larger bronchi as well as the finer ones.

The history is usually indefinite. As a rule these patients entirely recover their strength and their ability to do work. Occasionally, in the more severe cases, there may be shortness of breath on exertion. Nearly always they report to the roentgenologist for examination because of abnormal auscultatory signs picked up by the clinician when consulted for some intercurrent disease.

The *x*-ray plate will show changes closely resembling those found in pneumoconiosis. Adopting the classification used by Pancoast, Miller and Landis in their article published in THE AMERICAN JOURNAL OF ROENTGENOLOGY, March, 1918, we find that these cases of gassing simulate the condition described by these authors as Group 1, the stage of irritation. As in the lungs irritated by the inhalation of dust, we find that the bronchial markings are unusually prominent. Reaching out from the hilus like a bush in the winter time the thickened stalks and twigs of the bronchi extend to the mid-portion of the lung, standing out clear and distinct, with no splotches of exudate to mar or confuse the picture. The bush is symmetrical; it is not confined to one lobe, or to the upper more than the lower portion. It reaches out from the hilus evenly, into all lobes, and is present on both sides. As a rule, the extension is more into the middle lobe on the right side, and into the lower portion of the upper lobe on the left. Because of the overlying heart shadow, the involvement on the right is more apparent than it is on the left. In some instances, added to the outermost twigs, are finer linear markings reaching to the periphery. In the more severe cases, there may be an area or two of localized atelectasis.

Should the gas be chlorine, or should the exposure to chloropicrine or phosgene be unduly prolonged, then the picture is varied by lesions of the trachea and largest bronchi. This condition is differentiated from the early cases of pneumoconiosis in two particulars. The hilus shadow may not be enlarged; its enlargement when present is caused by the chronic bronchitis that sometimes persists. In the second place, there are no small areas of increased density to give the characteristic mottled appearance of dust inhalation.

The diagnosis from pulmonary tuberculosis is ordinarily not difficult. The distribution, the uniformity, and the absence of areas of consolidation, suffice to make the distinction clear. In certain instances, however, the presence of areas of atelectasis or emphysema, particularly when these occur in the upper lobes, may confuse the diagnosis considerably. Given the history of gassing, a consideration of the pathology that may ensue will assist in making the interpretation less difficult.

THE PRACTICAL APPLICATION OF THE SPHERE GAP TO ROENTGENOTHERAPY*

By H. J. ULLMANN, M.D.

Roentgenologist St. Joseph's and Children's Memorial Hospitals, Chicago

CHICAGO, ILLINOIS

IN looking through the literature on roentgenotherapy one cannot help noticing the great variation in spark gap used by different workers in obtaining essentially the same results. It would seem, according to later writers, that such variations should produce results varying proportionally to the differences in gaps used and that, with the same gap, distance, milliamperage and time, essentially equal effects should be obtained, if Coolidge tubes be used. It is well known, however, that this does not occur in practice. What is an erythema dose with one machine is not necessarily the same with another. If we use the same voltage, distance, intensity and time we would expect to get approximately the same effects with transformers of similar type, but the difficulties of working out dosage when changing from one machine to another or when trying to duplicate another worker's results with a given dosage are very real.

Why is one not able, with accurate meters and the Coolidge tube, to obtain as uniform results from a given dosage as with the alkaloidal drugs given hypodermatically? There one expects uniform results in the same type of patient whether a record or a Luer syringe is used provided the same quantity and quality of the drug is used.

In measuring dosage of the roentgen ray we have the same two factors, quantity (represented by milliamperage, time and distance) and quality, depending upon voltage applied to the tube terminals. Wave shape, number of cycles, etc., are not taken into consideration, as there is little evidence at present showing their importance in roentgenotherapy. There is no question but that we get sufficiently accurate quantitative measurements, with the milliammeter, a clock and a tape measure; but what about the qualitative?

The usual method of measuring voltage is in terms of spark-gap between blunt points, sometimes in kilovolts as read on a meter in the primary circuit; and as these seemed much like using an elastic tape measure to measure distance the following investigation was undertaken to determine how great the inaccuracy of the orthodox method of measuring voltage (penetration) was. Before taking up the results of actual measurements made at the tube the drawbacks of the needle gap and voltmeter on primary will be briefly taken up.

In measuring voltage with a needle gap considerable inconsistency has been found by investigators, and this seems especially true of European workers. Quoting J. Lustgarten[4]: "Those that have worked with the gap specified (standard A. I. E. E. needle gap) know that it is difficult to check the American values and even to repeat their own results on successive days. One reason for this lies in the effects on the brush discharge of humidity, pressure and temperature, position of the needles with respect to the supports and neighboring objects and the local conditions in the circuit. The brush discharge in the case of needle points always precedes the spark (except at very small distances). A screening by metallic discs at the back of the needles will not prevent humidity, pressure and temperature destroying the standard gap."

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*Read at the Midwinter Meeting, Central Section of The American Roentgen Ray Society, St. Louis, Mo., Feb. 21, 22, 1921.

To realize this inconsistency one has only to turn to the tables derived by different investigators showing the relation between distance of separation and the breakdown voltage. For example:

U. S. Army *X*-Ray Manual:

40 KV	Gap 3 inches
50 KV	Gap 4 inches

etc., the ration being 10 KV per inch plus 10.

Peek, *Dielectric Phenomena in High Voltage Engineering,* first edition:

40 KV.	Gap 2 13/32 inches
50 KV	Gap 3 3/17 inches

etc.

Raper, *Dental Radiography,* first edition:

10 KV per inch.

Knox, third edition, p. 19. Type of gap not stated:

110 KV	4 inches
150 KV	8 inches
190 KV	12 inches
230 KV	16 inches.

This table obviously refers to a sphere gap and shows the difficulty one would have in attempting to correlate his work with the English standards.

The needle gap is also cumbersome if one attempts to use it accurately. Section 245 A. I. E. E. Standardization Rules specifies the following:

"The sparking points should consist of new sewing needles supported axially at the ends of linear conductors which are at least twice the length of the gap. There should be no extraneous body near the gap within a radius of twice its length."

How many roentgen plants are equipped with a gap built according to the above? The average gap as commonly used brings in many sources of error not found in the standard. Peek[2] makes the following statement:

"The needle gap is unreliable at high voltages because, due to the brush discharge and broken-down air that precedes the spark-over, variations are caused by humidity, oscillations, and frequency.

"The needle gap is also inconvenient because needles must be replaced after each discharge; the spacing becomes very large at high voltages, and the calibration varies somewhat with the sharpness of the needle."

"A higher voltage is required to spark over a given needle gap when the humidity is high than when it is low.

"All spark gap curves of whatever form of gap must be corrected for air density—that is, altitude and temperature. For low voltages the spark-over of the needle gap decreases approximately as the air density. At higher voltages the effect becomes more erratic, probably due to humidity."

In using a KV meter on the primary even greater sources of error may be encountered. To quote Chubb and Fortescue[3]:

"The most usual method of measuring the high tension voltage is to measure the primary potential and multiply by the ratio of the transformer. Voltages obtained by this method are generally very much in error due to the distributed capacity in the high tension winding of the transformer, harmonic distortion of the applied voltage wave and the capacity of the terminal bushings and the apparatus to which the high voltage winding is connected. The effective low tension voltage is usually indicated so that there is no measure of the maximum unless a pure sine wave of voltage is applied, there are no appreciable distortions due to the harmonic components of the exciting currents and the capacity regulation can be corrected."

If the usual methods of measuring voltage (penetration) are so faulty, what is the remedy? Engineers have been using a sphere gap for a number of years to measure high voltages and it is well known to be the most accurate practical method. It is more consistent, the breakdown voltage being affected only to a negligible degree by widely varying conditions of atmospheric pressure, humidity, proximity of neighboring bodies, etc.; more convenient because the terminals do not have to be renewed and it requires less space.[4] Under certain conditions the breakdown of the air gap between equal spheres is very constant and the sphere gap that has already been suggested as a standard for high voltage measurements has been found to be more reliable than the usual methods of test.[3] The results of many tests show the breakdown voltage to be independent of wave shape and frequency when expressed in terms of the maximum value of the voltage wave.[8] Farnsworth[5] quotes Weicher's *Mitteilungen über Forschungsarbeiten auf dem Gebiete der Ingenieurmessen,* Berlin, 1911:

"For sphere gap used over a separation not greater than the diameter of the spheres the influence of the factors of humidity, temperature, pressure, frequency and electrical capacity on the sparking voltage is as follows:

"Humidity—No effect.

MACHINE A

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
30	25	out	31	2⅛	34.5
35	25	"	35	2⅞	39
40	25	"	40	3½	49
45	25	"	45	4¼	56
50	25	"	50	4⅞	62
55	25	"	55	5¾	71
60	25	"	59	6⅜	77
65	25	"	64	7¼	81
70	25	"	69	7⅝	88
75	25	"	74	8	93
80	25	"	79	8⅞	98
76	5	1	113	5½	60
85	5	2	102	8⅛	77
85	5	10	88	8⅝	89

MACHINE B

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
35	25	out	1	3	46
46	25	"	2	4⅝	56
57½	25	"	3	5½	70
47	5	"	2	5	58
58	5	17	3	6	70
62½	5	9	4	6	65
63	2	7	4	6	62
70	5	7	5	6	62
73	5	5	6	6	65
76	5	10	5	7½	73
78	5	10	[illegible]	[illegible]	80

ERRATA

The following corrections were received from Dr. Ullmann after the article had been printed:

p. 197: *Ingenieurmessen* should be *Ingenieurwesen*

p. 198: first column: MacKee formula should read:

$$\frac{\text{gap} \times \text{time} \times \text{milliamperes}}{\text{distance}^2} = 36/64$$

p. 198: second column, table:

In caption, V^1 and V^2 should be U^1 and U^2

Third line, last column, —110 should be —11.

S.G. KV
52
60
51
60
68
74
60
70
80
90

S.G. KV
54
55

tubes were tested. The findings are as follows:

8	5	
9	2	
9	6	

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"The most usual method of measuring the

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"For sphere gap used over a separation not greater than the diameter of the spheres the influence of the factors of humidity, temperature, pressure, frequency and electrical capacity on the sparking voltage is as follows:

"Humidity—No effect.

"Temperature—Sparking voltage is inversely proportional to the absolute temperature.

"Pressure—Sparking voltage is directly proportional to the barometric pressure.

"Frequency—Within commercial range—20 to 75 cycles—frequency has no effect on the sparking voltage.

"Electrical capacity—No influence."

If the sphere gap is so accurate it should prove any variation of voltage measurements made in estimating *x*-ray dosage. In order to test this the following procedure was carried out in a number of hospitals and private laboratories at Chicago.

The roentgenologist was requested to set his machine for a definite voltage and milliamperage such as he used in therapy and then the voltage was measured at the tube terminals with a sphere gap. Only Coolidge tubes were tested. The findings are as follows:

MACHINE A

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
30	25	out	31	2⅛	34.5
35	25	"	35	2⅞	39
40	25	"	40	3½	49
45	25	"	45	4¼	56
50	25	"	50	4⅞	62
55	25	"	55	5¾	71
60	25	"	59	6⅜	77
65	25	"	64	7¼	81
70	25	"	69	7⅝	88
75	25	"	74	8	93
80	25	"	79	8⅞	98
76	5	1	113	5½	60
85	5	2	102	8⅛	77
85	5	10	88	8⅝	89

MACHINE B

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
35	25	out	1	3	46
46	25	"	2	4⅝	56
57½	25	"	3	5½	70
47	5	"	2	5	58
58	5	17	3	6	70
62½	5	9	4	6	65
63	2	7	4	6	62
70	5	7	5	6	62
73	5	5	6	6	65
76	5	10	5	7½	73
78	5	12	5	8	80

MACHINE C
No auto transformer

Gap in inches	*Milliamperes High Button*	*S. G. KV*
4½	27	52
5	27	60
5	5	51
6	5	60
7	5	68
8	5	74
	Low Button	
6	5	60
7	5	70
8	5	80
9	5	90

MACHINE D
No auto

Gap in inches	*Milliamperes*	*S. G. KV*
6	3	54
6	5	55
8	3	70
8	5	73
9	2	75
9	6	82

MACHINE E
No auto

Gap in inches	*Milliamperes*	*S. G. KV*
7½ to 8	5	75

MACHINE F
Auto transformer

Gap in inches	*Milliamperes*	*S. G. KV*
6	2	65
6	6	65
8½	5	82

It is easily seen from an examination of the above that there is considerable variation of voltage where one would expect uniformity from the results of his spark gap readings.

In order to get these findings in terms of dosage the following table was made. Column C is the gap between points in inches as measured by the operator. KV is the actual voltage at the tube as measured by the sphere gap. U^1 is an arbitrary unit based on the MacKee formula—

$$\frac{\text{distance}^2}{\text{gap} \times \text{time} \times \text{milliamperes}} = 36/64 =$$

one unit, and represents what the operator thought he was using. U^2 is derived in the same way, using 70 KV instead of a 6 inch gap, and represents what he actually got. 70 KV was taken because it more nearly represents the actual voltage at the tube when the point gap registers 6 inches.

Per cent plus or minus represents the difference between what the operator thought he was using and what was actually used.

	C	*KV*	U^1	U^2	*Per cent*
Machine A	5¾	71	.96	1.01	+4
Machine B, setting 1	6	65	1.00	.93	—7
Machine B, setting 2	6	70	1.00	1.00	100
Machine C	6	60	1.00	.85	—15
Machine D	6	55	1.00	.80	—20
Machine F	6	65	1.00	.93	— 7

From the above table it is readily seen that if an operator using machine D should change to A and give what he had been in the habit of using for an erythema dose he would actually give 30% more. Conversely if operator of A transferred to D and gave what he supposed would be an erythema dose he would actually be using only 77% of the amount.

	C	*KV*	V^1	V^2	*Per cent*
Machine A	8	93	1.00	1.03	+3
Machine B	8	80	1.00	.89	—11
Machine C, setting 1	8	80	1.00	.89	—110
Machine C, setting 2	8	74	1.00	.82	—18
Machine D, setting 1	8	73	1.00	.81	—19
Machine D, setting 2	8	70	1.00	.78	—22
Machine E	8	75	1.00	.83	—17

In this table 90 KV was taken as representing 8 inches of back-up and an 8 inch gap the unit for deep therapy.

From the above it can be seen that if what would be an erythema dose on machine D, setting 2, was given with machine A, the patient would receive 1.32 times the dose, while if the readings used on A in producing an erythema were used on D only 76 per cent of the dose would be received.

If dosage were based on kilovolts instead of spark-gap and machines were calibrated so that one knew that certain settings would produce a definite voltage one should be able to change from one machine to another and expect to get the same results without previously testing out the effects on a patient. Also, a roentgenologist could publish the results obtained from a certain dosage with the knowledge that those who attempted to duplicate his results would at least use the same quantity and quality of rays.

There is nothing difficult in using a sphere gap. In fact it is easier as there is no corona and no preliminary sparking. It either fires or it does not, and the difference of a small fraction of a millimeter determines the sparking point. It is easily calibrated to read directly in kilovolts, and the machine once calibrated for the settings in common use, it will only be necessary to recalibrate at long intervals or when tubes are changed or different control buttons used.

CONCLUSIONS

The present method of estimating quality or penetration by parallel spark-gap between blunt points is exceedingly and unnecessarily inaccurate and is equivalent to measuring tube distance with a rubber band for a tape measure.

The use of the sphere gap in estimating voltage between tube terminals is accurate enough for all practical purposes and is actually easier to use than blunt points due to absence of brush discharge.

If the number of kilovolts used were stated instead of the amount of spark-gap back-up in reporting dosage the results could be duplicated by other workers as easily as in giving drugs hypodermatically and would be an advance in dosage standardization.

I wish to thank Dr. W. D. Coolidge for his advice and assistance in this work.

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THE VALUE OF PROPHYLACTIC X-RAY TREATMENTS*

By SAMUEL STERN, M.D.

Radiotherapist to Mount Sinai Hospital and Chief of the Radiotherapy Department of the Mount Sinai Dispensary

NEW YORK CITY

It is rather difficult to determine the value of treatments intended to prevent the recurrence of ailments presumably cured. Nevertheless there are certain indications that justify our drawing definite conclusions as to the results accomplished by the aid of these treatments.

If we know through long experience that in a series of similar cases we may expect a certain number of recurrences, and then find that as the result of treatments carried out this number has been diminished, we are justified in presuming that our treatments have been of some value.

Conclusions reached upon these premises are always open to the objection that perhaps the series of cases, while apparently similar, have in reality not been quite the same. Every surgeon has his own statistics as to his percentage of recurrences in malignant cases operated by him, and they vary in a large degree. Another, and in my opinion, more convincing method of reaching conclusions as to the value of prophylactic treatments, is to take selected individual cases of a character which in the opinion of the operating surgeon would unquestionably result in the recurrence of the lesion operated for. If in these cases we succeed through our treatments in preventing this expected recurrence, we are in a much better position to show concrete proof of the value of the treatments carried out.

The object of this paper is to describe a number of cases which without some interference would have unquestionably resulted in a recurrence, and to show that by a series of prophylactic *x*-ray treatments this expected recurrence has never materialized.

Case I. Mrs. F. S., sixty-two years old, referred to me by Dr. H. Herman in October, 1911, with a diagnosis of papilloma of the tongue.

Patient had a small growth, about the size of a lima bean, on the edge of the right side, at about the junction of the second and last third of the tongue. There was something suspicious about the appearance of the lesion, and I reported to Dr. Herman that in my opinion we were dealing with an epithelioma and not a papilloma. We decided to remove a small section for microscopical examination, this to be followed by immediate fulguration.

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*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14-17, 1920.

The examination was made by Dr. Harlow Brooks and the lesion was found to be an epithelioma. The fulguration (not dessication) was followed by periodical prophylactic x-ray treatments, with the result that up to date (nine years later) there is not the slightest sign of recurrence and the patient is apparently perfectly well.

The patient was treated with a unipolar x-ray tube which I devised in 1904.[1] This tube enables us to apply the x-ray in immediate contact with the part to be treated. While the output of this tube is rather small, the fact that it can be put in direct contact with the tissues makes it possible to administer considerable x-ray at each treatment.

CASE II. Miss A. B., forty-seven years old, referred to me by Dr. D. D. Goldstein in November, 1913. Mother died of cancer of breast in 1908. Patient first called on Dr. Goldstein in November, 1913. He found that she had a fair-sized tumor in the right breast, with axillary involvement. He advised immediate operation, but patient waited about two weeks, at the end of which time there was a very marked increase in the size of the tumor.

On operation there was found to be a large tumor of a very diffuse type, with marked involvement of the axillary glands. The sheets of all the blood vessels were involved and they all had to be stripped. The microscopical examination showed the tumor to be a medullary carcinoma of a very malignant type.

The patient followed up her x-ray treatments in a very reluctant way. She felt that she was wasting her time and money, so I had to be satisfied with treating the operated side where recurrence seemed most imminent. I succeeded in holding her for about one year, after which time she disappeared. I next saw her in July, 1919 (about six years after her treatment). The right side, where she had the prophylactic treatments, has remained entirely free; but the left side became involved and was operated on by Dr. D. A. Moschkowitz, who found a very malignant diffuse type of carcinoma with marked axillary involvement. I began to treat this side and up to date she has remained free of any recurrence.

I consider this a most instructive case. The original side (right) which was almost entirely involved in a very malignant type of extremely diffuse carcinoma, has remained free up to date (six years) following the prophylactic x-ray treatment, while the opposite side, which did not receive any treatments, was the site of recurrence.

CASE III. Mr. L. M. E., sixty years old, referred to me by Dr. Edwin Beer in January, 1916, for prophylactic x-ray treatments following a nephrectomy for hypernephroma of the left kidney. I will give Dr. Beer's description of this case, as published by him in the *International Journal of Surgery,* December, 1919:

"Mr. E., aged sixty odd years, was operated by the lumbar route for an acute hematuria from the left kidney. The diagnosis of hypernephroma of the left kidney had been made and the tumor mass could be felt in the left lumbar region. If ever a patient looked absolutely hopeless to the surgeon this patient surely did. The pelvis of the left kidney was filled with the tumor mass, which extended through the parenchyma and then had grown through the capsule of the kidney into the perinephritic fat, where a tumor as large as a good-sized fist was growing. The kidney was removed through the lumbar route, but naturally, with the tumor extending from the cortex, it seemed at the time that it would be impossible to deliver the kidney and tumor without spilling the tumor cells." (As a matter of fact, in a letter written to me by Dr. Beer on July 6, 1920, he states that he thought he must have spilled some of the viable tumor tissue.) "After removal of the kidney, all perinephritic fat was carefully excised, and the patient was subjected to intensive *x*-ray therapy. To-night (four years after operation) the patient presents himself in perfect health apparently. Last spring I made a complete examination and found no evidence of any disease."

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[1] *Medical Record,* Sept. 24, 1904.

Unfortunately I heard recently that this patient had passed away, suffering from a brain lesion, perhaps due to some metastasis in the brain. This I could not make sure of.

CASE IV. Mr. L., forty-five years of age, referred to me by Dr. A. Hyman, in August, 1916, for prophylactic treatment, following an operation for carcinoma of the testicle. I will quote from Dr. Hyman's letter to me (June 7, 1920) in reference to the case:

"Mr. L. was operated on July 19, 1916. In incising through the skin of the scrotum, a large amount of pus with necrotic material was evacuated; all the scrotal layers were edematous. A large tumor of the testicle was found, which had broken through the tunica and had infiltrated the scrotum. The tumor was necrotic in areas and the size of a fist. A typical orchidectomy was done, removing the cord up to the external ring. Pathological report: Carcinoma. In view of the fact that the growth had ruptured through the tunica and had become attached to and had infiltrated the scrotal tissues, I considered the prognosis very bad, and advised either *x*-ray or radium treatment. It is now almost four years since his operation and *x*-ray therapy; the patient, when last examined three months ago, was in excellent condition, with no evidences of local recurrence or metastases. A statement from his family physician, received a few days ago, confirms this report."

This patient, when first seen by me, had a great deal of induration in the operated region—so much so that I even feared at the time that a local recurrence was imminent. He also had considerable induration in the inguinal region, and Dr. Hyman felt quite confident that unless some method was found to prevent it a local recurrence was unavoidable.

CASE V. Mrs. L., fifty-three years old, operated on April 14, 1916, by Dr. Cragin for double cystic ovaries. On section, both cysts showed a cystic and a firmer solid new growth, with part of the capsule invaded by tumor tissue. At the time of the operation, one of the cysts ruptured and the contents spilled into the peritoneum. On microscopical examination, the solid portion showed nests of large cells and a well-marked alveolar arrangement. A diagnosis of adeno-carcinoma was made. This condition was unsuspected before and even during the operation, so the operation was not as thorough and radical as it would have been had the condition been recognized. As part of the capsule was involved and the contents of the cyst spilled into the peritoneum, recurrence was much to be feared.

Prophylactic *x*-ray treatments were carried out for about a year and a half, and there has been no sign of recurrence up to date (four and a half years after operation).

About two months ago this patient was operated upon for a gangrenous appendix. At this time the surgeon carefully explored the pelvic organs and found the uterus freely movable, without the slightest sign of recurrence. She made an uneventful recovery.

I have treated a number of other cases that I think would also clearly demonstrate the value of prophylactic *x*-ray treatments, but my time does not permit me to go into detail about these, as I would like to say a few words in regard to the technique and dosage that I have been using.

Prophylactic *x*-ray treatments, to be of value, must be efficient and must be persisted in for a considerable period. If possible, they should be kept up for about three years after the operation. This is very difficult. Most of the patients will be tired of the treatments long before this period expires, and it can only be carried out if you have an intelligent patient to deal with and if there is a proper cooperation with the operating surgeon and the family physician.

I try to give the treatments in the following routine where I can: First treatment, as shortly after operation as possible; the next two treatments, at about three weeks' intervals; the next two at four weeks' intervals. This is followed by treatment at six weeks' intervals for the balance of the first year. The second year treatments are given at two months' intervals, and the third year, at three months' intervals.

Of course, the treatments given the first year are the most important, and in the majority of cases you will find considerable difficulty in holding your patients longer than this; but whenever possible, try to get them to persist the full time.

In treating them, be sure to take in as large an area as possible, with special attention to the glandular region surrounding the involved area, also the parts where experience has taught us to expect most probably a metastasis. For instance, in carcinoma of the breast the opposite side should get some treatments—not necessarily as many as the involved side; and, in addition, I think it is advisable to treat the lumbar spine, where many of the metastases will appear.

I think the time will come when these patients will be given a complete *x*-ray bath—in fact, I believe it is quite feasible now. Instead of using small fields, we can have our tube at a distance of about 16 or even 20 inches, take in large areas at a time, and expose the entire body from all directions. I have not tried this as yet, but I am seriously thinking of doing so.

The cases reported above were all treated with the small field cross-fire method.

Dosage.—Try never to produce an erythema in these cases. It unnecessarily frightens the patients, discourages them from persisting with the treatment, and leads to telangiectases and other unpleasant skin conditions. I never use more than three-fourths of my maximum dose at any exposure. I find it more satisfactory to speak of maximum dose, and fractions thereof, than of a definite number of X. Your maximum dose never varies, while the measurements in figures of X generally do.

In standardizing my apparatus I find that the following figures represent my epilating dose—that is, a dose which will produce epilation without an erythema. I have taken this as a standard maximum dose, above which I never go.

Apparatus.—Forty centimeter air-cooled coil, with gas and mercury jet interruptor. Coolidge tube.

Distance	*Spark-gap*	*Ma.*	*Time*	*Filter*
8 inches	9 inches	5	10	4 mm. aluminum and several layers of photographic paper.

In giving these treatments, I use the above formula, except that the time is seven and a half minutes instead of ten. The tendency has been recently to abandon the aluminum filters for those made of copper and zinc. These metals have the advantage of increasing the *x*-ray penetration, but have the disadvantage of requiring much longer exposures. Where you have a large area to cover, this time element becomes of great importance, especially in patients who do not stand the treatments well and who are subject to various kinds of constitutional disturbances. Still, I think that probably we shall have to make the best of this disadvantage. If there is any additional therapeutic value in higher penetrating rays, these patients ought to get the benefit of it.

In closing, I wish to say that I firmly believe sufficient evidence has been gathered by this time to justify our belief in the value of prophylactic *x*-ray treatments. Every operation for malignancy should be followed up with these treatments, and these patients given the additional chance to escape recurrence.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

H. M. IMBODEN, M.D., *Editor* · PAUL B. HOEBER, *Publisher*

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY

WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921

Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

SIXTH ANNUAL MEETING THE AMERICAN RADIUM SOCIETY

BOSTON, JUNE 6 AND 7, 1921. HEADQUARTERS, HOTEL BRUNSWICK

WASHINGTON MEETING

PRELIMINARY ANNOUNCEMENTS

Plans for the program of the Annual Meeting of the Society next fall are now well under way. Dr. René Ledoux-Lebard will give the Caldwell Lecture on the subject of "Deep Roentgen Therapy." It is planned to give a much larger place on the program to papers than has hitherto been done. The plan is to hold the meeting for four days, giving the entire first day to papers on therapy and to have the papers on physics during the forenoon of the second day. This will enable those who are interested only in therapy to leave about the middle of the second day, while those interested only in roentgen diagnosis would not feel it necessary to attend until the beginning of the second day. Those interested in both diagnosis and therapy would probably wish to be present the entire four days.

It is believed that this plan will make the meeting of interest to a much larger number of men. It is requested that those who have papers to present at the meeting communicate with the President of the Society at as early a date as possible.

A. C. CHRISTIE.

The Twenty-second Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY will be held in Washington, September 27, 28, 29 and 30, 1921. Headquarters, meetings and exhibits will be at the Hotel Washington, Pennsylvania Avenue, opposite the Treasury.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of THE AMERICAN ROENTGEN RAY SOCIETY. Mr. A. Gümpert, Manager of the New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him.

The hotel rates are as follows:

Hotel Washington, every room having private bath with shower, tub and running ice water (European plan only):

	Per day
Single rooms	$5.00 to $7.00
Double rooms (double bed)	8.00
Double rooms (twin beds)	10.00 to 12.00

The New Ebbitt (European plan only):

	Per day
Single room without bath	$2.50
Single room with bath	4.00
Double room without bath, each person	$2.50
Double room with bath, each person,	3.50

Also a number of large suites, both with and without bath, which will comfortably accommodate upwards of four persons. On these suites they would make a rate of $3.00 per day each person, with bath, or $2.00 per day each person without bath.

For information regarding the program, those wishing to read papers or to show slides at the meeting should communicate direct with the President, Dr. A. C. Christie, 1621 Connecticut Avenue, N. W., Washington, D. C.

For information regarding commercial exhibits and other business matters connected with the meeting, address the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

It is hoped to arrange for special trains and cars from various sections. Details regarding this will be announced later.

ANNUAL MEETING WESTERN SECTION

The officers of the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY are making plans for their second annual meeting. They have selected Portland, Oregon, as the place of meeting, and the time has been set for May 27th and 28th. This time will permit of a continuous trip for the western men who desire also to attend the A. M. A. meeting in Boston.

The Pacific Coast Roentgen Ray Society will meet at the same time and place, the two organizations being the guests of the Portland Roentgen Club, a very active organization of specialists.

The Secretary of the Western Section would welcome a visitor or two from the East with papers or demonstrations, and can assure them of a very enjoyable meeting. Address Dr. Warner Watkins, Box 1328, Phoenix, Arizona.

NEW COMMITTEES

SAFETY, AND LAWS AND PUBLIC POLICY

At the last meeting of the American Roentgen Ray Society two important committees were created, a Committee on Safety and a Committee on Laws and Public Policy.

The Committee on Safety is charged with the investigation of all matters pertaining to the dangers incurred in the practice of roentgenology, and recommending measures to increase its safety. This will necessitate an extensive investigation by the committee in order that it may collect data covering the experience of as many men as possible. It is hoped that all members of the Society and readers of the JOURNAL will cooperate with the Committee both by sending to it, voluntarily, any information that may be of value, and by answering any questions that may be sent to them with regard to accidents and injuries, both electrical and *x*-ray, that have occurred in their practice.

The Committee's recommendations with regard to the practical value of safety devices, as well as those for the elimination or lessening of the dangers pertaining to the practice of roentgenology, will undoubtedly be of great value to roentgenologists.

The Safety Committee consists of Prof. J. S. Shearer, Chairman, Cornell University, Ithaca, N. Y., Dr. P. M. Hickey, and Dr. W. D. Coolidge.

The Committee on Laws and Public Policy was authorized by the following resolution which states its purpose:

"During the coming year there shall be appointed by the President at his convenience a committee of three to be known as the Standing Committee on Laws and Public Policy: that it shall be the duty of this Committee on Laws and Public Policy to keep the Society informed as to changes in laws and legal decisions; to cooperate with similar committees from other medical societies and public welfare associations, generally, to the end that this Society shall be found in a proper attitude toward all matters of legislative and public policy which may be found to involve the welfare of the Society or properly to demand the Society's cooperation."

This committee consists of Dr. E. H. Skinner, Chairman, Rialto Building, Kansas City, Mo., Dr. Charles F. Bowen, and Dr. E. A. Merritt.

Any member of the Society who has any matter which he wishes to bring to the attention of this committee should communicate with the Chairman.

A. C. CHRISTIE.

SIXTH ANNUAL MEETING
THE AMERICAN RADIUM SOCIETY

PRELIMINARY PROGRAM

The Sixth Annual Meeting of THE AMERICAN RADIUM SOCIETY will be held at Boston, June 6 and 7. The place of meeting for scientific work will be the Harvard Medical School, the headquarters the Hotel Brunswick. Following is the preliminary program:

Monday, June 6th, 1921

Morning Session

A. EXECUTIVE SESSION.
B. SCIENTIFIC SESSION.

Treatment of Primary Carcinoma of the Vagina with Radium. Leda J. Stacy, M.D., Rochester, Minn.

Treatment of Uterine Cancer by Radium. Harold Bailey, M.D., Rochester, Minn.

Histologic Changes Occurring in Carcinoma of the Cervix following Radiation, with Special Reference to the Factor of Distance. Charles C. Norris, M.D., and Norman S. Rothschild, M.D., Philadelphia. (By invitation.)

Radium in the Treatment of Carcinoma of the Breast as an Adjunct to Surgery. Ben R. Kirkendall, M.D., Columbus, Ohio.

Radium Combined with X-Ray Treatment in Carcinoma of the Breast. George E. Pfahler, M.D., Philadelphia.

Treatment of Glandular Enlargements with Radium. Russell H. Boggs, M.D., Pittsburgh.

Afternoon Session

A Comparison of Radiation Dosages Attainable by Use of Radium on and without Tumors. Charles H. Viol, Ph.D., Pittsburgh.

Dosage in Radium Therapy. Gioacchino Failla, E.E., New York.

A Comparison of X-Rays with Gamma Rays. William Duane, Ph.D., Boston. (By invitation.)

Hyperthyroidism—Classification — Basal Metabolism in Diagnosis—Renal and Blood Findings—Treatment by Radium. R. E. Loucks, M.D., Detroit, Mich.

Action of Radium on the Blood and Blood-Forming Organs. Isaac Levin, M.D., New York.

Experiences in the Treatment of Nasopharyngeal New Growths. Curtis F. Burnham, M.D., Baltimore.

Treatment of Multiple Papilloma of the Larynx in Children. Gordon B. New, M.D., Rochester, Minn.

C. SHORT EXECUTIVE SESSION.

Monday Evening

ANNUAL DINNER.
PRESIDENT'S ADDRESS. (Lantern slides.)

Tuesday, June 7th, 1921

Morning Session

A. SHORT EXECUTIVE SESSION.
B. SCIENTIFIC SESSION.

Radium in Dermatology. Frank E. Simpson, M.D., Chicago.

Dosage in Superficial Lesions. William S. Newcomet, M.D., Philadelphia.

Treatment of Carcinoma of the Rectum. Douglas Quick, M.D., New York.

Treatment of Prostatic and Bladder Carcinoma. Hugh H. Young, M.D., Baltimore.

Treatment of Malignant Disease of the Bladder. Benjamin Barringer, M.D., New York. (By invitation.)

Treatment of Brain Tumors by Radiation. Henry K. Pancoast, M.D., Philadelphia.

Tuesday Afternoon

Clinic at the Huntington Memorial Hospital, by invitation and under the direction of Dr. Robert Greenough, Director of the Hospital.

CANADIAN RADIOLOGICAL SOCIETY

NOTICE OF CHANGE OF MEETING PLACE

The Annual Convention of the Canadian Radiological Society will be held this year in conjunction with the Ontario Radiological Society at Niagara Falls, Ontario, May 31 to June 4, inclusive. Members of the C. R. S. will please take notice of this change.

An invitation is extended to all members of the profession to be present, as the program to be presented will well justify the time spent.

L. K. POYNTZ, Secretary-Treasurer.

THE THIRD CONGRESS OF THE ITALIAN SOCIETY OF MEDICAL RADIOLOGY

The Third National Congress of Radiology took place in the Institute of Electrotherapeutics and Radiology in Rome, October 28 to 30, 1920. It was well attended by radiologists from all parts of Italy. The exhibits of radiological apparatus were large and of great interest.

The opening speech at the meeting was delivered by Prof. Ghilarducci, in which he very ably demonstrated the progress made by Italian radiology both from a scientific and industrial standpoint, and showed that they have been able to maintain a place equal in importance to that of other countries.

Prof. Bertolotti of Turin also delivered an interesting lecture on radio-activity in biology and chemistry.

Prof. Perussia (Milan) discussed the radiological researches of the heart and large vessels, extensively illustrated with clinical and radiological records of personal study.

Prof. Ponzio (Turin) then discussed fully the most recent physical and biological discoveries of radio-therapeutics and the practical results. His statements were strengthened by a large personal experience in the actual state of the therapeutics of cancer. This subject was discussed at length by the leading clinicians.

The program also included numerous other talks of most appealing interest showing fully the activity and scientific value of Italian radiology.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

THE RADIOGRAPHY OF THE CHEST, VOL. I.—PULMONARY TUBERCULOSIS. By Walker Overend, M.A., M.D. (Oxon) B.Sc. (Lond.) Pages 120; 108 Illus. Price $5.00. C. V. Mosby Company, St. Louis, 1920.

This is a book of moderate size containing ninety-nine radiograms and nine diagrams. The first chapter deals briefly with technique and the radiographic appearance of the normal chest. The author then discusses the classification of lesions and gives his own, which is a most rational one based on the clinical course and the radiographic findings.

The author, who is evidently a clinician as well as a radiographer, gives a brief digest of the history, physical examination, clinical diagnosis, and in some instances, the post-mortem findings with each radiogram. The arrangement of text and illustrations is not altogether good, for in many instances the notes and radiograms of the same case are several pages apart, making it inconvenient to consult the radiogram while reading the interpretation of the same.

The illustrations are generally good, but in some cases the entire pulmonary area is not shown.

In the last chapter there is a brief discussion of various topics, such as the relative value of clinical and radiographic examination; incipient tuberculosis; tuberculosis in the great war; the heart in pulmonary tuberculosis, etc.

While not a profound exposition of the subject, this work of a combined clinician and radiographer contains material which should be of interest to both the internist and the radiographer.

JOHN G. WILLIAMS

TRANSLATIONS & ABSTRACTS

GREENOUGH, ROBERT B., Boston. The Treatment of Tumors by *X*-Rays and Radium. (Read before the Fifth Congress of the International Society of Surgery, Paris, July 19 to 23, 1920.)

After speaking of the limited knowledge concerning the biological action of radium, the writer discusses the results of radiation of living tissue, which may be enumerated as follows: "(1) Living tissue may be destroyed *en masse;* (2) Growth may be temporarily inhibited; (3) The rapidity of growth may be stimulated; (4) The manner of growth may be modified."

While massive destruction of a complex tissue demands a dose of radiation sufficient to kill the cells of the different types of the area involved, the effects of stimulation, inhibition and modification of growth may be exerted upon individual cells and individual types of cells in the tissue area exposed to radiation, depending upon the dosage, the susceptibility of the cells to radiation, and doubtless upon other factors of which we have insufficient knowledge at present. In the treatment of non-malignant disease and for palliative (non-curative) treatment of cancer, all of the cells exposed need not be destroyed. But to cure cancer by radiation, the exposure must be shown to be 100 per cent efficient in destroying the disease, or recurrence is to be expected.

The massive destructive effect of the lethal dose of radiation is used in the non-metastasizing carcinoma of the skin in both the squamous and basal-celled varieties. It is also used in some of the metastasizing forms of cancer where the removal is impossible. Here the insertion method by the use of the bare tubes of emanation or of the needles holding radium salts or emanation at their tips, has proved effective in producing massive destruction. This method has been employed safely near the surface of the body where normal suppurative processes and their discharges may take place without the risk of deep and dangerous infection. Burying tubes of emanation in deeply situated tumors has proven unsatisfactory, either because the dosage has been too small to be effective or a degenerative process has resulted with secondary infection that made surface drainage necessary. For the treatment of certain malignant tumors on the surface of the body where operative removal is impossible, or in combination with operation, when the operative procedure alone was insufficient, the insertion of tubes of emanation with the resulting massive destruction, finds a field of great usefulness.

As the absorbed rays rather than the penetrating rays produce the greatest effects upon living tissues, it is probable that the beta rays are the most concerned in the production of massive destruction with the radium. For this reason massive destruction is produced only in close proximity to the source of radiation.

The phenomenon of temporary inhibition is shown by the fact that cells exposed to radiation for a certain time remain quiescent for a considerable period, only to awake to active and continued growth after the radium effects have passed away. The time before activity begins again is variable, in some cases several years.

That small doses of radiation produce a stimulant effect upon growth is generally conceded. It is impossible that one dose of radiation should contribute a constituent of growth that was previously lacking as would be the case if a plant or an animal were supplied with a greater quantity of light, heat or moisture. The primary inhibition of growth followed by the later increased rapidity of cell division would appear to justify the assumption that some damage was done by the radiation and as a result the normal processes in response to injury were excited.

In addition to the effect on the tumor, there is an effect seen in the normal tissue surrounding the diseased area. The earliest observable histological changes after radiation are a new growth of the cell elements in the blood vessels and connective tissue. It is impossible to state how much is due to radiation and how much to the natural processes or inflammation and repair excited by the damaged tumor tissue. There is, however, a marked new growth of connective tissue before any recognizable change in the epithelial cells is seen.

The modification of growth resulting from the radiation of living tissue depends upon the tissue investigated to a great extent. Normal tissues may be made abnormal, and developing embryonic cells may be made to develop in an abnormal manner. This ability of radiation is shown in the clinic in its application to the relief of benign skin lesions such as papillomas and keratoses. In these the destructive effects are not needed or desired. After a mild reaction the deeper cells which were formerly growing in an abnormal manner begin to grow more normal. The abnormal cells are cast off and the lesion heals without a scar. While this action is of greatest value in the treatment of non-malignant lesions, it can be counted upon but little in the attempt to eradicate malignant disease. No modification of growth of cancer cells short of death and destruction of every cell is sufficient to cure the patient of cancer.

The so-called "selective action" of radium upon tumor tissue is next considered. Some benign lesions such as papillomas and keratoses, which yield to the "modifying" effects of radium without the destructive effect, are of the class of so-called "precancerous" lesions, but this does not permit us to presuppose a similar reaction when dealing with cancer tissue.

Different tissues show a variation in sensitiveness to radiation. Lymph-adenoid tissues and those of the ovary and testicle are especially sensitive. Certain tumors of lymph-adenoid tissue, such as malignant lymphoma (Hodgkin's disease) and lympho-sarcoma appear to exhibit a definite and positive sensitiveness, in that when they are first subjected to deep radiation, the tumor masses shrink and occasionally disappear, without undue damage to the normal tissues overlying. But it has been the experience of the writer, that the changes are temporary, and although a recurrence of the tumor masses in the same or in other lymph nodes may again react to radiation, sooner or later the sensitiveness is lost. In myeloid leukemia, profound changes in the blood picture, in the size of the spleen, and in the patient's comfort result from deep radiation of the spleen, but again the improvement is temporary. These two diseases are often evoked as evidence of the selective action of radium. This action, however, is one of modification of growth, or even possibly of stimulation of certain types of tissue, rather than a destructive effect.

The cells of the ovary and testicle are, again, notoriously susceptible to radiation. Ovarian function and menstruation can be brought to an end by intra-uterine applications of radium, and with all of the symptoms of the menopause. Azoöspermia has been frequently found in male x-ray workers, although there is reason to believe that recovery from this condition may subsequently occur when exposure ceases.

When cancer is superficial and accessible to direct radiation of any desired dosage, either by surface applications or by insertions, it can often be permanently destroyed. In no case of actual cancer, however, has the writer seen success in this purpose without the production of a destructive lesion, and in many there is a failure to destroy the disease entirely. In some cases, as when a basal cell carcinoma involves the bones of the face or a carcinoma of the tongue extends into the tissues of the floor of the mouth, the cancer tissue seems to be more resistant to radiation than the normal issue in the vicinity. In these cases, at least, no specific sensitiveness is manifest.

Advanced cases of cancer of squamous cell or glandular origin which have extended to the regional lymph nodes are frequently subjected to treatment with radium. The enlargement of the regional nodes is commonly accepted as evidence of extension having taken place. However, it must be remembered that other causes for the enlargement of the lymph node exist and that it is not at all uncommon to see an inflammatory process in regional lymph nodes due to the ulceration of the primary carcinoma. Even in the presence of a certain amount of infiltration of cancer cells, inflammatory changes may occur and lead to fluctuation in the size of the lymph nodes far too rapid to be interpreted as being due to cancer growth alone. In almost every fatal case of carcinoma of squamous cell or glandular origin extension of the disease into the regional lymph nodes ultimately takes place. In none of these cases has the writer seen a permanent destruction of the disease following radiation. Shrinkage in size of a large node is observed, but he is inclined to attribute this, when it occurs, to a change in the accompanying inflammatory process rather than to a destruction of cancer tissue.

Cells engaged in mitotic division are generally believed to be more sensitive to radiation than resting cells. The large number of mitotic figures is a characteristic of cancer tissue. It is not unreasonable to suppose that a part, if not the greatest part, of the supposed sensitiveness of cancer tissue to radiation is dependent upon the number of cells actually undergoing mitosis during the period of exposure. If this is so, a fractional destruction of the tumor only can be expected as a result of repeated deep radiation, for during each exposure only those cells then in mitosis would be affected, and a diminishing but constant residue of unaffected cells would always remain to awaken into activity and grow at some subsequent time and produce recurrence. It must be recognized that there is abundant evidence that repeated exposure to radiation produces a gradual loss of sensitiveness on the part of the tissues exposed, so that the attempt to accomplish a fractional destruction of tumor tissue by deep radiation is by this fact, also, made more difficult. The clinical observations of the result of deep radiation on cancer tissue are in accord with this theory, for although inhibition or retardation of growth may be observed, the destruction of the tumor and the cure of the disease are not accomplished.

In general, the experience in the clinic and in the laboratory has shown that the massive destructive effect of radiation (by direct application) is necessary for the cure of the disease.

While certain tissues show a sensitiveness to deep radiation which is of value in the treatment of non-malignant disease and in the palliative (non-curative) treatment of malignant disease as well, the cure of cancer (estimated in surgical terms on a three to five year basis) is not accomplished without the massive and total destruction of the tumor by the direct application of the source of radio-activity.

K. F. KESMODEL.

QUICK, DOUGLAS. The Combination of Radium and the *X*-Ray in Certain Types of Carcinoma of the Breast. (*Surg., Gynec. & Obst.*, Vol. xxxii, No. 2, Feb., 1921.)

The writer reviews the existent literature briefly, and quotes some interesting early results. He notes that in the past, radium and *x*-ray have not been sufficiently combined. He describes the technique in use at the Memorial Hospital for burying emanation tubes in the tissue; presents an outline of the histologic changes which follow such a procedure and which furnish a rational basis for radium therapy. He thinks that the results following the burial of small emanation tubes (2 or 3 mc.) are better than those following the same total dosage delivered in a shorter time. Filtration, in this method, is through a thin glass wall only, and this permits the use of nearly all of the beta radiation—a very important factor. Subsequent *x*-ray treatment is carried out as though no radium treatment had been given. During the past two and one-half years, 78 cases of carcinoma of the breast have been thus treated at the Memorial Hospital. Of these, 7 show complete regression, and have remained well for periods of from three months to two years; 21 cases show a partial regression, and are still progressing (no case in this group has been observed less than five months); 24 cases showed temporary benefit; 19 of these have died, but without lighting up of the original process; 10 cases showed no improvement (these were far advanced cases with widespread metastases); 9 cases were not followed; 7 cases have been under observation too short a time for any report; 12 of the foregoing cases are reported in detail, with micro-photographs illustrating the histologic changes occurring; 58 of these cases were treated for recurrences and metastatic growth; only one of these was operable. He notes that radium seems to control the pleural pain better than *x*-ray. He concludes that the *x*-ray is useful in the treatment of every case of mammary carcinoma; that radium may be combined with *x*-ray to great advantage in a certain number of cases; that radium is useful mainly in flat or bulky recurrences, axillary involvement, inoperable primary cases, and in cases refusing operation; and that radium and *x*-ray may convert an inoperable case into an operable one at times.

LOWELL S. GOIN.

BAEJTER, F. H., AND FRIEDENWALD, JULIUS. Roentgenological Aspects of Lower Right Quadrant Lesions. *Am. J. Med. Sc.*, November, 1920, clx, 639.

The importance of lesions of the right lower quadrant is quite evident. Among the most frequent lesions occurring in this locality may be mentioned:

1. Appendicitis.
2. Incompetent ileocecal valve and ileal stasis.
3. Dilatation of the cecum with retention.
4. Adhesions and angulations.
5. Ulcerations due to tuberculosis.
6. Ulcerations due to carcinoma.

Both bismuth meal and enema are employed. The ingested meal should reach the cecum in five to eight hours, according to the meal employed. Delay in the passage of the meal may be due to dilatation of the cecum, to ptosis or adhesions, to ileal stasis and angulation, ulceration or carcinoma. A bismuth enema, given in the knee-chest position, is also of advantage in studying lesions of the right lower quadrant.

1. *Appendicitis.*—Acute appendicitis may be more accurately diagnosed by filling the cecum to localize the site of involvement and then (in certain instances where the onset of a lower right pneumonia is preceded by symptoms simulating appendicitis) to rule out involvement of this organ by showing the absence of a painful point over the cecum or any limitation of mobility.

Chronic appendicitis: The appendix can be examined only if the lumen is potent and will admit bismuth; otherwise it cannot be visualized. The specific technique emphasized by Case for examination of the appendix is as follows:

(1) Examination of the patient on the horizontal fluoroscope. The tube must be under the table and the screen over the abdomen, to insure the proper examination.

(2) The abdomen must be palpated with the gloved finger or a spoon for localization of a point of tenderness.

The time of examination is of importance. In six hours the cecum fills, and under palpation the appendix may fill. From then on until the bowels are empty it may be visible. When the appendix remains visible for more than a day or two after the bismuth examination it is a dangerous appendix. The bismuth-filled appendix has been noted weeks after an examination. Where there is no local tenderness on pressure, appendicitis can usually be excluded. Where the cecum is limited in motion there is always the possibility that this may be due to inflammation even if the appendix is visualized and not tender. The frequency of visualization of the appendix with bismuth meal varies with different men—35 to 90 per cent. Not every visualized appendix is abnormal. The mere filling of the appendix does not necessarily indicate pathology. When it is curled up, kinked or bound down it probably is pathological.

The stomach is often pulled toward the right lower quadrant due to omental adhesions. As a reflex condition chronic appendicitis may give rise to a picture similar to that of duodenal ulcer; gastric and duodenal hypermobility, with a definite filling defect of the duodenal cap.

2. *Incompetent ileocecal valve and ileal stasis.*—In one sixth of 3000 cases examined by Case incompetency of the ileocecal valve and ileal stasis was noted. Bismuth meals which after twenty-four hours had completely left the ileum were found at thirty-six and forty-eight hours to have regurgitated through an incompetent ileocecal valve into the ileum. The patient should be on his back on the horizontal fluoroscope. The rectal point should be inserted not more than one or two inches. The container of the barium enema should never be elevated more than two feet. Ordinarily 1200 c.c. (100° F.) will fill the colon without causing irritation. The cecum must be well filled and palpated under the fluoroscope. Plates should be made with the patient in the prone position. When a bismuth meal is given it collects in the terminal ileum in about four hours and leaves in eight to nine hours. Delay in passage may be due to spasm, incompetency of the ileocecal valve, bands of adhesions, displacement, prolapse or tumors; dilatation of the terminal ileum points to obstruction.

3. *Dilatation of the cecum with retention.*—The ingested bismuth meal appears usually in the cecum in from seven to ten hours. Delay in passage may be due to dilatation and retention of cecum. This may be associated with constipation, appendicitis, sub-acute inflammatory lesions, or enteroptosis. It is not the position of the cecum which is most important but the function of this part of the bowel. The constipation associated with this condition may be very marked and on operation the retained fecal material may cling closely to the walls of the cecum leaving bleeding areas when separated, showing evidence of a subacute infection.

4. *Adhesions and angulations.*—Angulations

and kinks occurring in the right lower quadrant are often due to adhesions either from appendiceal disease, pelvic inflammation or some local inflammatory process. The delay in the passage of the bismuth will give a clue to this.

5. *Ulcerations from Tuberculosis.*—The clinical picture of intestinal tuberculosis is of little aid in early cases. The roentgenographic examination may give definite information. The most constant finding is intestinal hypermotility, the entire meal being discharged in twenty to twenty-four hours; this may be with or without gastric residue. A spastic condition of the bowels affecting especially the cecum and ascending colon is noted and often irregular filling defects can be seen.

6. *Ulcerations from carcinoma.*—There is in this condition a large irregular constant filling defect of the cecum. Filling defects from adhesions and fecal contents must be carefully differentiated by re-examination at a later date.

In conclusion, the *x*-ray examination should be looked upon as an aid in the diagnosis of the lesions above indicated. The possibility of error is so great that mistakes will necessarily be made. If the roentgen diagnosis is diametrically opposed to the clinical and all other findings it is probably wise to adhere to the clinical interpretation.

L. R. S.

HERNAMAN-JOHNSON, FRANCIS. The Use of *X*-Rays as Immunity-Raising Agents before and after Operation for Cancer. (*Brit. Med. J.*, June 12, 1920.)

The knife may be a means of disseminating stray cancer cells. If before this occurs we can bring about either a weakening of the malignant cells or an increase in the resistance of the body tissues, or both, the chance of successful colony formation by the parent growth will be lessened. Experimental research has shown that mouse cancer which has been exposed to radiation is grafted into fresh tracts with difficulty or not at all. Clinical evidence supports this fact as applied to man. The *x*-rays act as much by their stimulating or regulating action upon the body as by their depressing effect upon cancer. Embryonic cells are injured or destroyed by doses of radiation which have little or no effect upon the normal tissue. The general stimulating and regulating action of the *x*-rays is of more value than their specific effect upon the pseudo-embryonic cells. The immunity produced by *x*-rays is partial and non-specific. It is not proven that that resulting from the use of radium is any different. Pre-operative treatment should be given. The healing of the wound is not delayed and the only argument against such a procedure is that it delays operation for two or three weeks. This argument, to be valid, implies that the cancer, though improving visibly, is invisibly spreading in depth. This does not occur. If immunity to cancer can be raised by pre-operative raying, we should obviously carry out raying after operation. So long as we are not dealing with actual recurrence, we should be careful to give too little rather than too much. The fact that small doses increase the immunity to cancer and that large ones decrease or abolish it must be kept in mind.

LOWELL S. GOIN.

MARTY, L. A. The Modern Treatment of Malignancies. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

In the United states 65,000 people died of cancer in 1918; 200,000 people are suffering at all times from this condition. We are no longer justified in "cutting it out" and allowing the percentage of recurrences to be high and the mortality what it is at present. Only the man doing *x*-ray work and radium therapy will be able to do work that is fair to the patient, for specialists are not made over night in this more than in any other special branch. Breast cases, for example, should have preliminary raying to block the lymphatics and lower the vitality of the malignant cells. A massive dose should be delivered into the wound before closure of the flaps and post-operative raying should be begun as soon as the patient has recovered from the shock of the operation. The axillary and clavicular regions, and in fact the entire chest should be rayed. The same applies to malignancy elsewhere. In cancer of the pelvic organs radium may be added to advantage. Radiation is indicated in every case, as much suffering is relieved, toxemia lessened, and the patient made more bearable to those about him.

L. S. G.

Hubeny, M. J. *X*-Ray Treatment of Exophthalmic Goiter. (*Illinois Med. J.* June, 1920, p. 383.)

The writer reviews briefly the history of *x*-ray therapy in goiter and sums up the histologic basis for such treatment. He has used two techniques, one is to give each of these areas (including the thymus) two thirds of an erythema dose, using a 9 inch spark-gap and filtration of 4 millimeter aluminum and one millimeter leather with target skin distance of 8 inches. This dose is repeated in three weeks. The second technique consists in using the same filtration, the same spark-gap and a 14 inch skin distance, applying a half-erythema dose over each of six areas: right anterior thymus; left anterior thymus; right anterior thyroid; left anterior thyroid; right and left posterior cervical ganglionic areas. Roentgenization over the cervical ganglionic areas inhibits thyroid secretion. The second technique is preferred when the patient is not highly toxic, quicker results are obtained with the first technique. Early treatment increases the chances of recovery, exophthalmos disappears in 40 per cent of cases. The first dose should be small to guard against an increased toxemia. Caution should be used in treatment of cases after operation, as there is danger of the production of hyperthyroidism.

L. S. G.

Fischel, Ellis. The Use of Radium in Carcinoma of the Face, Jaws and Oral Cavity. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

The recognized methods oftreatment are operative removal, destruction by *x*-ray, radium, high frequency or the actual cautery. The *x*-ray can be relied upon to cure nearly all basal cell epitheliomas of the fact. At present it cannot be depended upon to destroy the more malignant types even when located on the surface. The writer has never seen a lesion located within the mouth benefited by the *x*-rays. Radium has some advantages over the *x*-ray, particularly the fact that a known amount may be buried in a mass. Whatever means are employed, the tumor should be destroyed as completely as possible at the first attempt. If cancer of the lip, the results under radium treatment have been so striking that operation is no wreserved for those who have had paste or unsuccessful operative treatment before. Results within the oral cavity have not been so successful, no cures having been noted. If the growth involves the bony jaw, operation is advised, and is followed by radium.

L. S. G.

Vilrande, G. E. Observations on the Treatment of Neoplasm. (*Brit. Med. J.*, February 14, 1920.)

The writer reports a number of interesting case histories of various malignancies treated by radium. He thinks that there is no doubt as to the value of radiation of the site of glands after removal, and pleads for the routine raying of the scars after lip operations. Rodent ulcers do best under radium. Sarcomata are much more easily inhibited than are carcinomata. Breaking down malignant glands as follow an epithelioma of the lip, does not do well under *x*-ray treatment. Neoplasm of the lungs reacts to hard, heavily filtered rays, but the writer has not seen one disappear. He suggests that perhaps the frequent occurence of epithelioma on lupus that has been treated by small doses of unfiltered rays may have some significance. Larger doses of harder, more heavily filtered rays are indicated in radiotherapy. The writer has doubled and tripled his dosage in the past two years.

Leighton, W. E. Inoperable Cancer. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

The responsibility for inoperable cancer rests (1) with the quack cancer specialist, (2) with the patient who neglects to consult a physician, (3) with the physician who fails to recognize the disease, or who attempts superficial surgery. The diagnosis of external cancer is not very difficult. Ulcerations which do not heal readily should arouse our suspicions, and tumors of all descriptions demand early investigation. The laity and the physicians must be educated to the fact that early diagnosis and operation will cure a large percentage of cancer cases. Palliative operation should be undertaken where possible. The removal of ulcerating and offensive masses by cauterization, electro-thermic coagulation or electric dessication may accomplish wonders. Deep roentgen therapy after removal of the skin has given excellent results.

L. S. G.

SEMON, H. C. The *X*-Ray Treatment of Acne Vulgaris. (*Brit. Med. J.*, May 22, 1920.)

The etiology and pathology of acne is that the effect of the rays on acne lesions is the inhibition of the physiologic action of the secretory cells of the sebaceous glands, and the dissolution of the fibrous capsules of the infected comedo. Whether or not this is correct, it remains a fact that the *x*-rays will cause involution, both of the comedo and the deep nodular abcsess and reduce scarring to a minimum. For simple cases unfiltered rays from a tube backing up between 4 and 5 inches spark-gap are used, giving a dose of four fifths Sabauraud B tint. This is not repeated within ten days. An erythema is not desirable.

When pustulation and dermatitis are marked, treatment is preceded by a few days' application of antiseptics and detergent lotions, after which doses of two-fifths B tint are given at ten-day intervals. In the more advanced stages, with intra- and sub-dermic nodules, periglandular fibrosis, etc., harder rays from a tube backing up between 5 and 6 inches of spark-gap are used, with five millimeters of aluminum filter, giving a full pastille dose. After two weeks half-pastille doses may be given at ten-day intervals. Local relapse is rare.

Acne can be permanently cured, no matter in what stage it may be, by judicious *x*-ray treatment.

L. S. G.

BRYAN, LLOYD. The *X*-Ray as an Aid in Diagnosis of Non-Tubercular Pulmonary Conditions. (*California State J. Med.* Vol. XVIII, No. 6.)

Lung abscess is seen as an irregular area of increased density, fading out gradually into normal lung tissue. If the cavity is only partly filled with fluid, a gas bubble may be seen above the fluid level. The large area of consolidation about the cavity may be misleading, and the surgeon will be disappointed in finding so small a cavity. Abscess must be differentiated from bronchiectasis in which condition the indurated areas are usually multiple. The peribronchial thickening of bronchitis never reaches the periphery. Primary and secondary pulmonary malignancy must be differentiated from both lung abscess and tuberculosis. Metastatic sarcoma give a picture identical with that of multiple small abscesses. Tuberculosis may be confused with pneumoconiosis, and may be coincident with it. Diagnosis should not be made from an *x*-ray examination, which is only an aid, and must be correlated closely with the clinical findings.

L. S. G.

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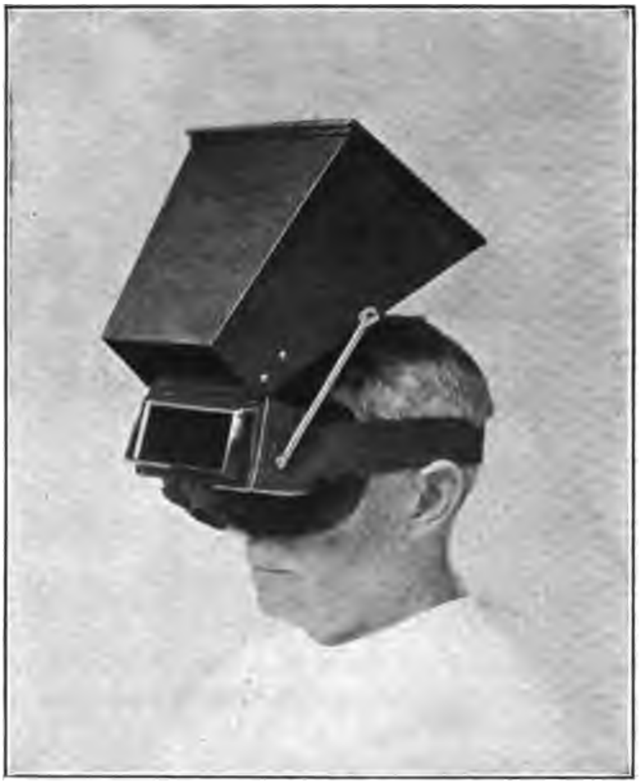

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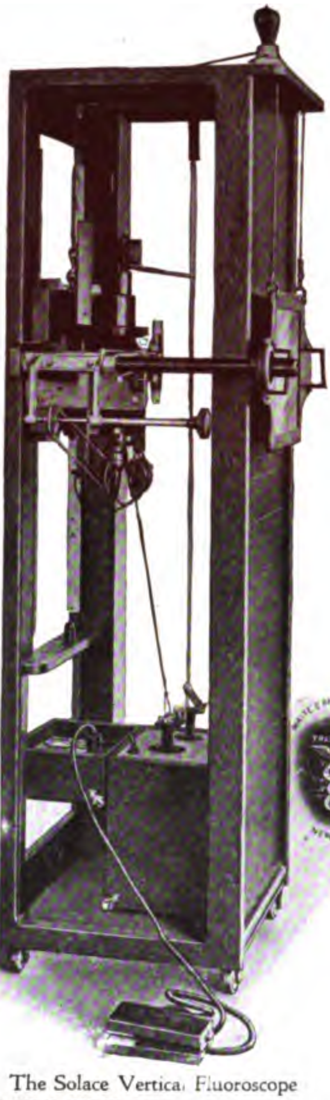

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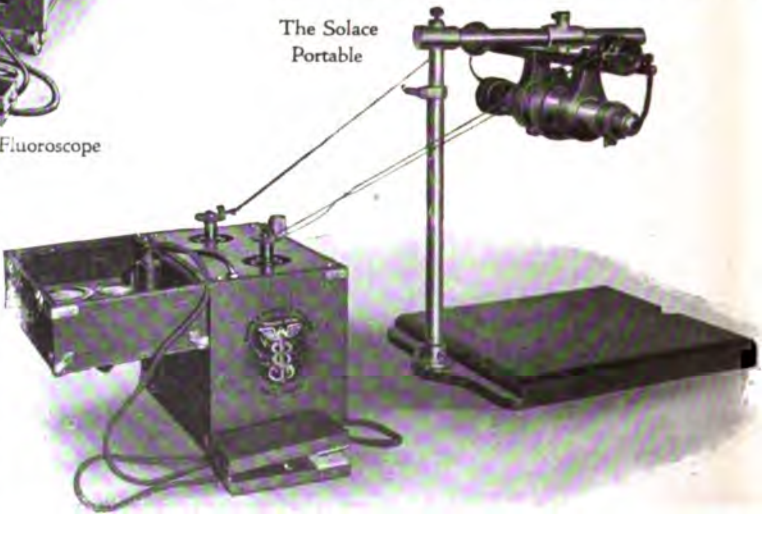

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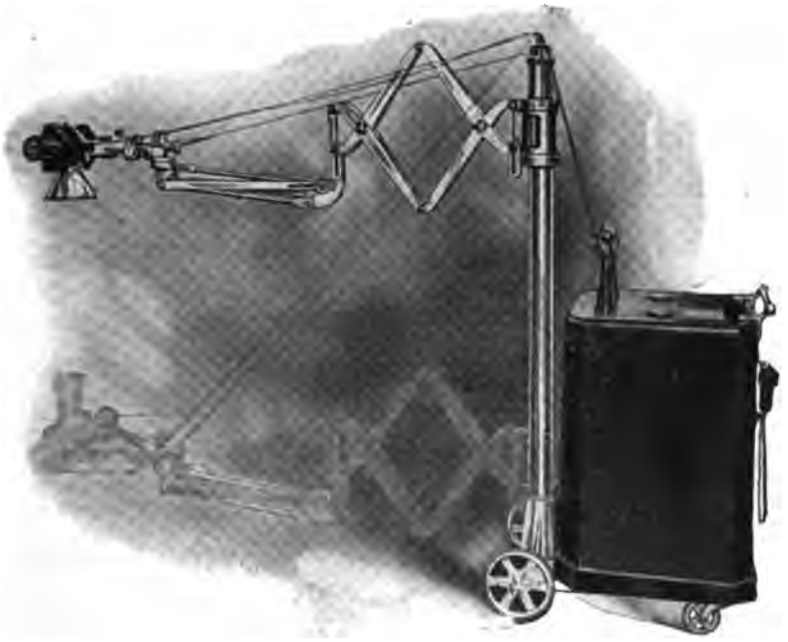

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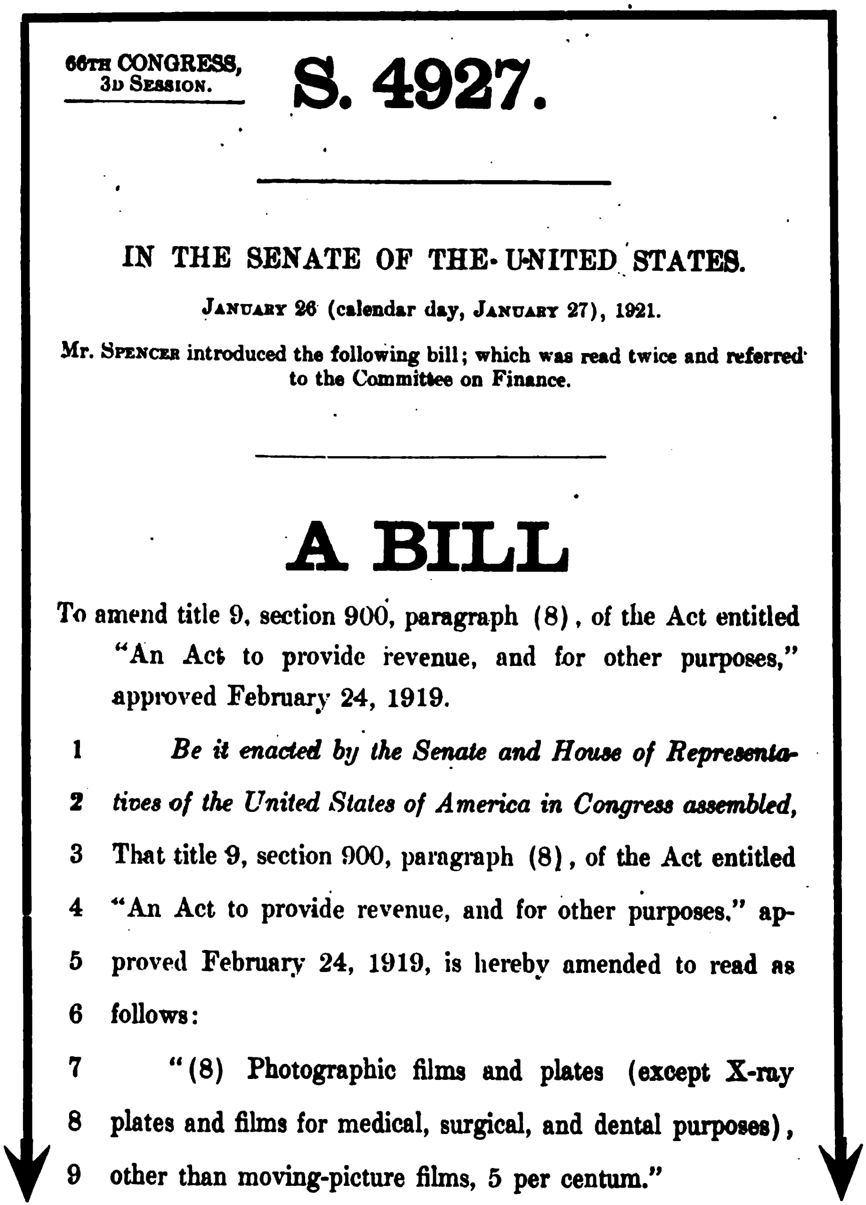

66th CONGRESS,
3d Session.

S. 4927.

IN THE SENATE OF THE UNITED STATES.

January 26 (calendar day, January 27), 1921.

Mr. Spencer introduced the following bill; which was read twice and referred to the Committee on Finance.

A BILL

To amend title 9, section 900, paragraph (8), of the Act entitled "An Act to provide revenue, and for other purposes," approved February 24, 1919.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title 9, section 900, paragraph (8), of the Act entitled "An Act to provide revenue, and for other purposes," approved February 24, 1919, is hereby amended to read as follows:

"(8) Photographic films and plates (except X-ray plates and films for medical, surgical, and dental purposes), other than moving-picture films, 5 per centum."

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FREDERICK H. BAETJER, M.D. & CHARLES A. WATERS, M.D.

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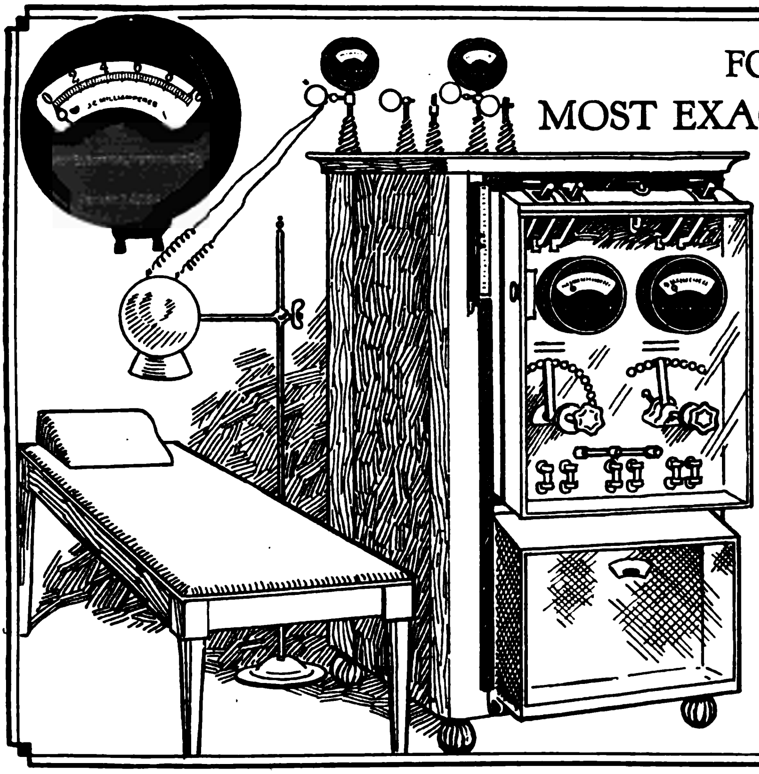

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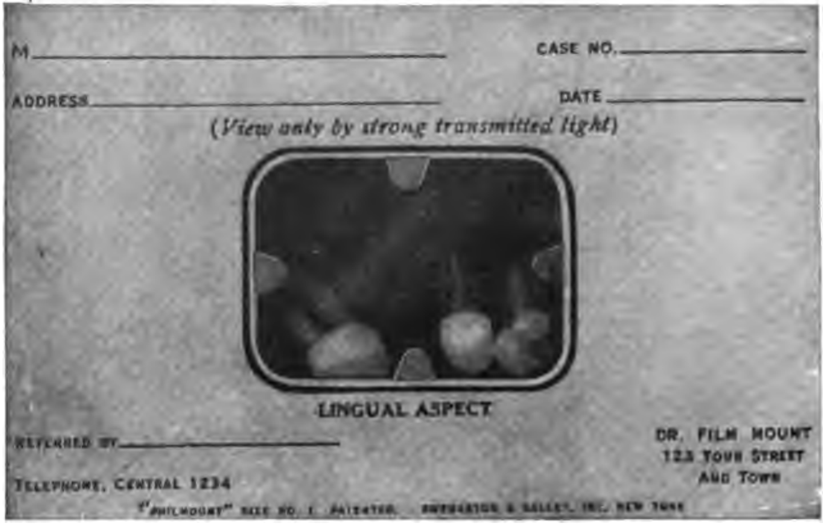

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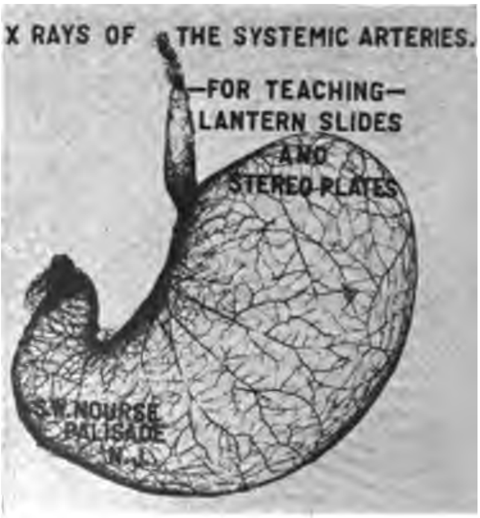

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IV. Technique of Mastoid Examination
V. Conditions Necessary for Proper Exposure of the Plate
VI. Development of the Plate

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i, Anatomical Key Plate; ii, Furunculosis in the Auditory Canal; iii, Simple Acute Mastoiditis; iv, Simple Acute Mastoiditis; v, Severe Mastoiditis with Mild Symptoms; vi, Mastoiditis with Bone Absorption; vii, Beginning Abscess Formation; viii, Asymmetrical Mastoids and Thin Cortex; ix, Perisineus Abscess; x, Perisineus Abscess and Sclerosis; xi, Extensive Perisineus Abscess; xii. Large Cholesteatoma; xiii, Cyst of the Mastoid; xiv, Diploetic Type and Chronic Otitis Media with Sclerosis; xv, Undeveloped Mastoids; xvi, Chronic Otitis Media; xvii, Infantile Type, Age 5; xviii, Epidural and Perisineus Abscess; xix, Mastoid Operation with Complete Removal of Cells; xx, Mastoid Operation with Incomplete Removal of Cells; xxi, Large Emissary Vein.

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With a Foreword by GEORGE S. HUNTINGTON, M.D., Prof. of Anatomy, Columbia University

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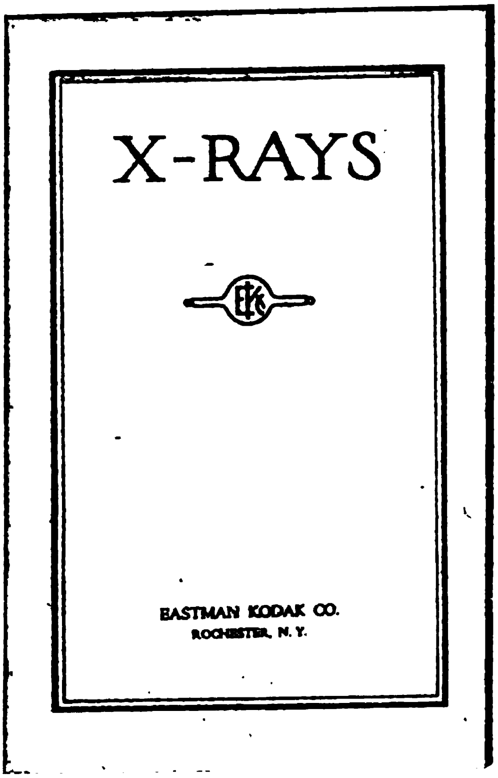

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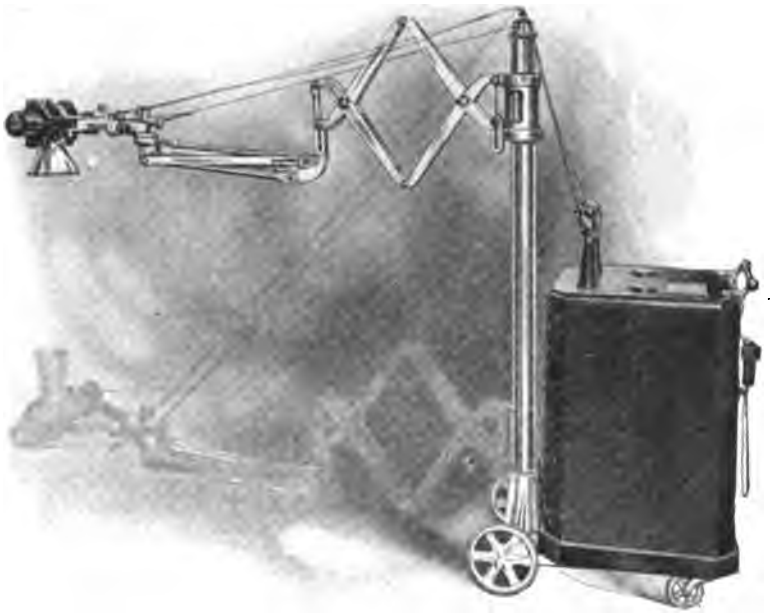

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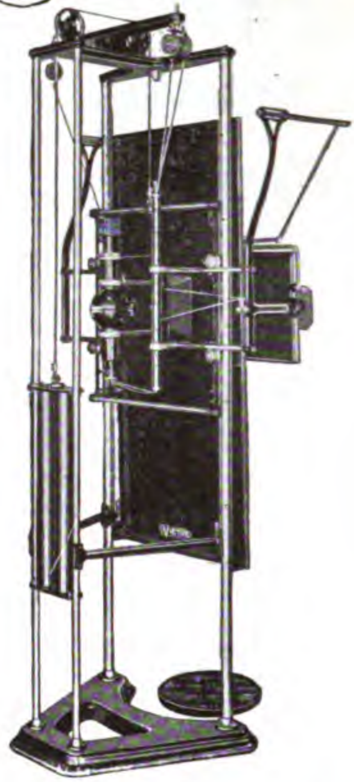

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THE ABSORPTION OF RADIUM RADIATIONS BY TISSUES

By GIOACCHINO FAILLA, E. E.
Physicist to the Memorial Hospital
NEW YORK CITY

THIS investigation was undertaken for the purpose of determining the absorption by different tissues of the radiation of radium filtered through various thicknesses of metal. The scope of the work was to apply the knowledge thus obtained to radium therapy.

DESCRIPTION OF APPARATUS

The apparatus used for the experiments is shown in Figure 1. The conical ionization chamber is made of lead, and is supported vertically on a suitable frame not shown in the diagram. It is 51 cm. long, 3 cm. in diameter at the smaller end, and 12 cm. at the larger end. The wall thickness is 0.8 cm. A thin steel rod, tapered to a point, is suspended along the axis of the chamber, and is carefully insulated therefrom. The rod is electrically connected to the leaf post P of the electroscope by means of a fine copper wire which runs through brass tubes filled with paraffin. The electroscope is made of lead 1 cm. thick. The inside dimensions are 2.7 by 6 by 7 cm. It is arranged (as shown in the lower part of the figure) so that the gold leaf is projected on a ground glass screen. The lead cone, brass tubes, and electroscope case are all connected to the ground at G. The gold leaf of the electroscope is charged by pulling a string attached to a bell crank, so that the rod R, which is connected to a suitable source of potential, touches the leaf post. The wire in the ionization chamber will then be at the same potential as the leaf. The charging potential is adjusted so as to bring the image of the leaf always to the same point *a* on the screen. In taking readings, the observer sits in front of the ground-glass screen, and, with a stop watch, measures the time it takes the image of the leaf to travel between the points *b* and *c* on the screen.

The supports for the source of radiation, filter, and tissue, are made of hard rubber and very thin mica, as shown at AB. They are placed at such a distance from C that the source of radiation is practically at the apex of the cone. In this manner the beam of rays which enters the cone fills the whole chamber. The metallic filters are placed just above the radioactive source; the tissue is placed on the mica window B which is 1.5 cm. above the support for the filters. With this arrangement it is possible to change the filter without disturbing the tissue in any way. The lower end of the ionization chamber is closed by a very thin sheet of mica.

The radiation we wish to measure is only the beam which enters the ionization chamber. It is necessary, therefore, to shield the electroscope itself from the radiation which the source emits in all directions. For this purpose a thick block of lead is interposed between the source and the electroscope, and the latter is so constructed that no stray radiation can enter it. The brass tubes are filled with paraffin for the same purpose of limiting the effect of the radiation to the air in the ionization chamber proper. The instrument was tested to see whether the shielding was sufficient, and it was found that the effect on the electroscope which was not due to the ionization chamber was negligible. Account had to be taken, however, of the "natural leak" of the instrument, that is, of the slow discharge of the electroscope leaf when the source of radiation which we wished to investigate was not present. This correction is made by subtracting the rate of fall of the leaf due to the natural leak alone from the rate of fall due to the combined effect of the radiation which enters the ionization chamber, and the natural leak.

It is important to bear in mind just what we are measuring with an apparatus of this sort, because on that depend the conclusions which we may draw from the experimental results. The cone of rays which enters the ionization chamber ionizes the air in it. The formation of ions implies that energy is being used up in the process, since work must be done to separate negative from positive electricity on account of the force of attraction between the two. This energy is supplied by the radiation. The difference of potential between the wire and the walls of the ionization chamber is sufficient to cause the positive and negative ions to be separated from each other as soon as they are formed, thus preventing their recombination. Under these conditions the electric current thus produced is proportional to the number of ions produced per second, which is a measure of the energy absorbed by the air in the chamber. The electroscope, used in conjunction with a stopwatch, measures this ionization current. Consequently the readings which we obtain in this manner are proportional to the energy absorbed.

The physiological action of radiation is dependent to a considerable extent on the amount of energy absorbed by the radiated tissue. It is evident, therefore, that ionization methods of measurement offer a good basis for the correlation of the physical factors of the dose of radiation administered and the physiological effects produced thereby. The method, however, has its limitations, which should be clearly recognized. In the first place, the medium in which the ionization is measured is a gas, and not tissue. When the constituents of the gas do not differ very much in atomic weight and relative proportions from the constituents of tissue, the absorption of radiation, mass per mass, is substantially the same. If we assume this to be true in the case of air, the thickness of tissue equivalent to the air in the ionization chamber of these experiments is about 0.6 mm. Secondly, the ionization of the air in the chamber consists of two parts, that produced directly by the passage of the beam of radiation through the air, and that produced by the scattered and secondary radiation excited by the rays which impinge on the walls of the chamber. When a metal ionization chamber is used, as in this case, the second term may be very important, according to the character of the radiation. Thirdly, the scattered and secondary radiations, which contribute to the effect in a deep-seated tumor, for instance, are quite different from their counterparts in the ionization chamber. These are the main physical differences between the conditions obtaining in laboratory experiments and in the treatment of patients. It is evident, however, that there are greater differences which are independent of physical conditions, but which are due to the inherent peculiarities of living matter. The physiological action of radiation depends not only on what takes place in the radiated tissue, but also on the reaction of the whole system. Naturally we cannot simulate this in *physical* experiments. Hence, in order to make practical application of the results obtained from physical experiments, it is necessary to conduct physiological experiments complementary to the former.

EXPERIMENTAL PROCEDURE

To determine the absorption of radiation by tissue it was necessary to have uniform parallel slices of tissue about 5 cm. square. The thicker slices were cut by hand, using a knife with a wide blade. The thin slices were cut by means of a meat-slicing machine with a specially ground knife, after the tissue had been frozen hard. Tissue hardened in formalin could be cut with this machine without trouble. The thickness of the slices of tissue was determined by placing each between two thin sheets of lead and measuring the total thickness with a micrometer caliper. When the thickness of tissue on the mica support was several centimeters, the total thickness was checked by placing a steel scale against the pile of tissue. This procedure was especially necessary in the case of a very soft tissue, because its weight flattened the bottom layers. The density of the tissue was determined as follows: The tissue, in one or several pieces, was weighed with an accurate balance. Its volume was then determined by measuring the amount of water which it displaced, and the density obtained by dividing the mass by the volume. The weight of the tissue used for this determination was in every case several hundred grams. For the metals and solid bone the volume was calculated from the dimensions of a rectangular slab of the material.

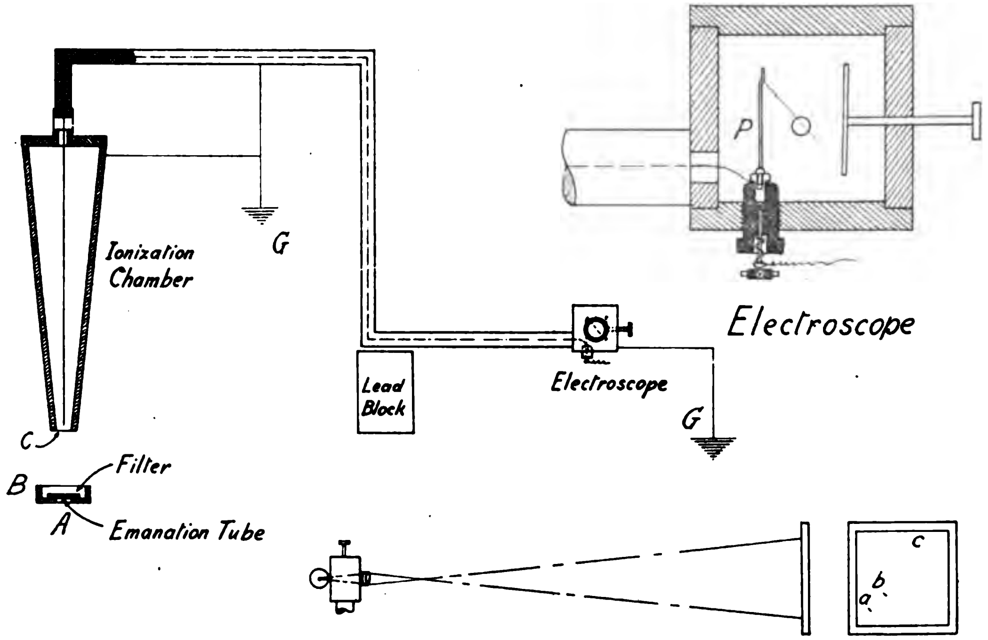

FIG. 1. Projection of Gold Leaf on Ground Glass Screen

The source of radiation used for these experiments was radium emanation enclosed in capillary glass tubes about 0.5 mm. in outside diameter and 14 mm. long. While the wall thickness of these tubes is sufficiently great (about 0.1 to 0.15 mm.) to absorb the alpha rays, it has little effect on the beta and gamma radiations. If such a tube, containing a suitable amount of emanation, is placed at A in the apparatus of Figure 1, the radiation will go through the very thin mica sheets at

B and C and will enter the ionization chamber without appreciable absorption. There it will ionize the air, and the electroscope will measure the ionization thus produced. Let us arbitrarily call the intensity of ionization in this case 100 units. If we place a slice of tissue 1 mm. thick on B, the radiation which enters the ionization chamber is only that part of the original beam which succeeded in getting through 1 mm. of tissue. This produces an ionization of 43 units in the chamber as measured by the electroscope. The addition of another millimeter of tissue (a total thickness of 2 mm.) reduces the ionization to 27 units. Continuing in this manner, for larger thicknesses of tissue, we obtain values of the intensity of ionization for different thicknesses of tissue interposed between the source of radiation and the ionization chamber. The results are shown graphically by curve A in Figures 3 and 4. A similar procedure using a metal or a metallic filter and tissue enables us to obtain the absorption curves shown in Figures 2, 3, and 4.

DISCUSSION OF ABSORPTION CURVES

In these experiments the ionization produced by the total radiation, beta and gamma, emitted by an emanation tube, was assumed to be 100 units. All other readings. therefore, represent percentages of the total radiation. As the range of values to be incorporated in the absorption chart is large, it was thought best to use a logarithmic scale. In this way, as the values decrease the scale is automatically increased. Furthermore, a logarithmic scale has the important advantage that it enables us to tell at a glance when the radiation becomes "homogeneous," because in this case the absorption curve is a straight line. For our purposes the radiation is homogeneous when successive equal layers of tissue absorb the same percentage of the radiation which reaches them. This means that the quality of the radiation remains substantially the same as it goes through the filter or tissue.

In Figure 2 are shown the absorption curves for different metals. It will be seen that the curves for metals of medium or low atomic weight become straight lines beyond a thickness of metal of a few millimeters. The curve for lead, on the other hand, does not become straight in the range of thickness shown in the chart. The mathematical law of absorption which applies to the straight part of the curve is

$$I = I_0 e^{-\mu d}$$

where I_0 = intensity of radiation falling on filter,

I = intensity of radiation passing through the filter,

d = thickness of filter,

e = Naperian base of logarithms,

μ = the coefficient of absorption.

The coefficient of absorption represents the fraction of the incident radiation which is absorbed or scattered per unit thickness of filter.* For the same quality of radiation, this is different for different absorbers, and for the same absorber it is different for different qualities of radiation. In the case of aluminum, for instance, the value obtained from the curve of Figure 2 is 0.11, and therefore 11% of the gamma radiation is absorbed per centimeter of aluminum. (The value given by Soddy and Russel[1] is 0.111, and by Rutherford and Richardson[2] is 0.115.) In the case of brass the value of μ for gamma rays is 0.35, so that brass absorbs $\frac{0.35}{0.11} = 3.2$ times more gamma radiation per unit thickness than aluminum. The thickness of lead used in these experiments (2 cm.) was not sufficient to give a straight line in the absorption curve. Hence it is not strictly correct to speak of a coefficient of absorption for this curve. However, if we make the calculation for the last part of the curve we find that μ equals 0.58, which is somewhat higher than the value of 0.5 given by Rutherford.[3] This shows that the hardness of the gamma radiation from radium increases with the thickness of filter beyond 2 cm. of lead. In fact, from the experiments of Tuomikoski[4] and others, it appears that the penetration of the gamma radiation of radium increases even after filtration by several centimeters of lead. Such excessive filtration, however, is entirely out of the question in radium therapy, on account of the weight of the filter and the diminution of the quantity of radiation which passes through it. Even for 20 mm. of lead the ionization produced by the transmitted radiation is only 1.5% of the value for the unfiltered beta and gamma radiation, and less than ¼ the value for radiation through 1 mm. of lead.

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* In thinking of the coefficient of absorption in these terms, care should be exercised to choose a unit of thickness which will make the amount of radiation absorbed by a filter of unit thickness a small fraction of the incident radiation.

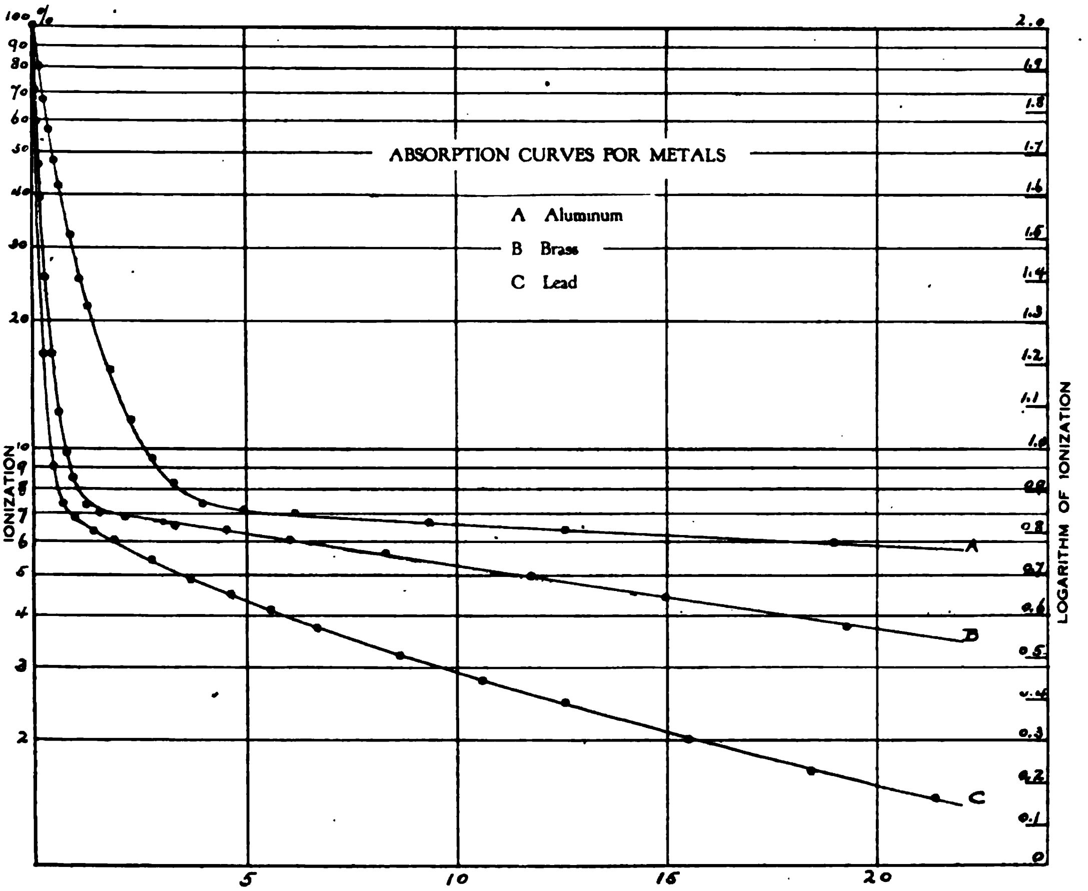

Figure 2.

Fortunately no such filtration is necessary in therapy. In the first place, the fact that the aluminum and brass curves become straight lines beyond a thickness of a few milllimeters indicates that radium radiation filtered through 6 mm. of aluminum or 2 mm. of brass is sufficiently homogeneous to be absorbed by these metals according to the exponential law given above, within the range of thicknesses shown in Figure 2. The reason is that for substances of low atomic weight the coefficients of absorption as here defined do not vary much with the wave length, for gamma radiation of the quality considered.[5] *A fortiori* this is true of the absorption of tissue, the principal constituents of which are much lighter than these metals. In the case of lead, the mechanism of absorption is further complicated by the fact that the element is an isotope of Radium B.[6]

In Figures 3 and 4 are shown the curves of absorption by tissue of the radiation filtered through different thicknesses of brass and lead respectively. The circles indicate the points which were experimentally determined. The largest thickness of tissue used in these experiments was about 7 cm. For this reason the prolongation of the curves to 10 cm. is shown in dotted lines. We are justified in extrapolating to 10 cm. because many other curves we have obtained in the course of our work, using up to 9 or 10 cm. of tissue, have been straight lines, within the limits of experimental error. In either chart the highest curve is for the total radiation, beta and gamma, emitted by the small capillary glass tube containing radium emanation. It will be seen that there is a sharp bend in the curve corresponding to a thickness of about 1 cm. of tissue. This is the point at which a transition occurs in the quality of the radiation, from a preponderance of beta and soft gamma rays to a preponderance of hard gamma rays. The presence of soft radiation is evident, however, even up to thicknesses of tissue of 5 or 6 cm.

The lowest curve, F, in either set represents the absorption of radiation by the metal filter alone. These curves are the same as shown in Figure 2, but plotted to a different scale. The absorption curves for filtered radiation branch out from these curves. The filters used were approximately ½, 1, 2, and 3 mm. of either brass or lead. For any point on the curve the thickness of tissue is added to the thickness of filter. Thus for the third curve, C, in Figure 3, we have: a brass filter 0.96 mm. thick reduces the ionization from 100 to 7.6%, the further addition of 1 cm. of tissue brings the ionization to 6.2%, and so on. The curves are plotted in this manner so that each is a complete absorption curve, starting with unfiltered radiation.

For deep therapy it is essential to use radiation which is absorbed exponentially by tissue; that is, radiation which is absorbed to the same extent by successive layers of tissue. If this is not the case, the skin and superficial layers will absorb a larger percentage of the incident radiation than corresponding layers of tumor tissue, and therefore will be affected more strongly, even if it were possible to use a parallel beam of radiation. As the dose is adjusted so as not to injure the skin, it follows that by using a filter which does not give a homogeneous radiation, the tumor does not receive as much radiation in proportion as it would if sufficient filtration were used. Thus, if the filter consists of ½ mm. of brass, from Figure 3 we see that the first centimeter absorbs $\frac{14.5 - 6.4}{14.5} = 56\%$ of the incident radiation, the second centimeter absorbs 9%, but the third and each subsequent centimeter absorbs only 7.7%. On the other hand, using 2 mm. of brass as a filter, the first centimeter absorbs 10%, the second, third, etc., 7.5%, and the difference, which in this case is due to the secondary radiation of brass,[7] is small. The further addition of a secondary filter of 2 or 3 mm. of rubber, which has about the same absorbing power as tissue, makes the percentage absorbed by the first and successive centimeters of tissue the same.

The criterion for the exponential absorption of radiation is that the absorption curve, when plotted to a logarithmic scale, be a straight line. From Figures 3 and 4, therefore, we can determine what filtration to use to fulfill this condition. Evidently there is more than one choice. However, not all possible combinations of primary and secondary filter which could be used are equally economical. In the first place, it will be seen that in no case is the absorption curve a straight line when the ionization is over 6%. This means that at best we can use for deep therapy only 6% of the radiation emitted by the bare glass tube. At this point it is interesting to note that when tissue is used as the absorber; the absorption is not exponential up to a thickness of about 5 cm. Accordingly if tissue or some organic substance of about the same density were used for deep therapy, a thickness of five or more centimeters would be necessary. Aside from the inconvenience

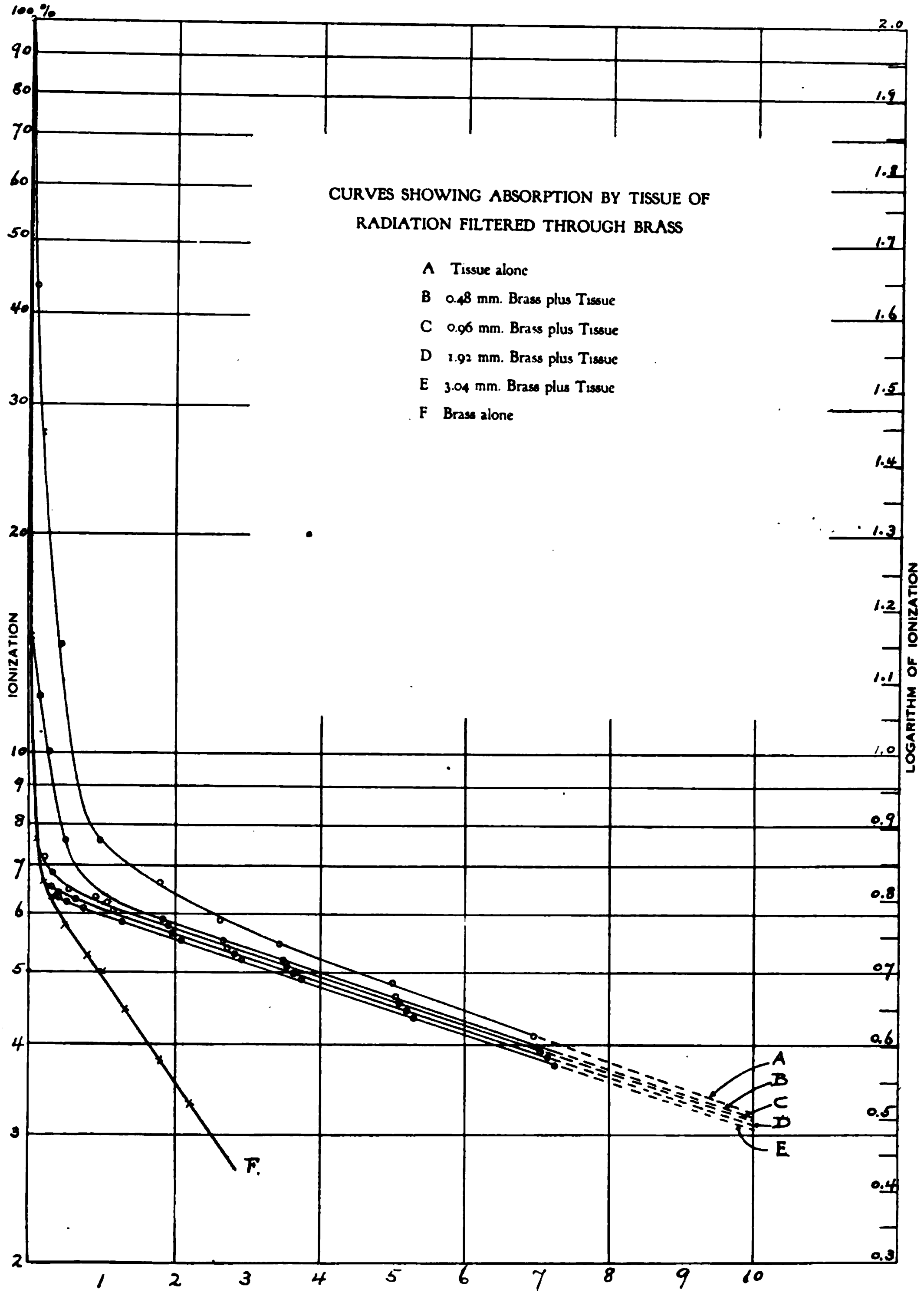
CURVES SHOWING ABSORPTION BY TISSUE OF RADIATION FILTERED THROUGH BRASS
A Tissue alone
B 0.48 mm. Brass plus Tissue
C 0.96 mm. Brass plus Tissue
D 1.92 mm. Brass plus Tissue
E 3.04 mm. Brass plus Tissue
F Brass alone
IONIZATION
LOGARITHM OF IONIZATION
100 %
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1
2
3
4
5
6
7
8
9
10
A
B
C
D
E
F.

FIGURE 3.

of such a bulky filter, its use would entail an unnecessary loss of radiation, because the ionization produced by radiation filtered through 5 cm. of tissue is 4.8%, while other filters can give 6%. The reason for this is that the diminution of the intensity of the beam of radiation passing through a filter of low atomic weight is primarily due to the scattering of the radiation and not to true absorption. Since the scattering by substances of low atomic weight is not very different for the different qualities of radiation, the softer components of the beam of radiation are not effectively eliminated in this manner. Hence substances of low atomic weight are not efficient filters,[8] and the large thickness required to obtain the proper filtration causes undue scattering and absorption of the penetrating radiation as well. This brings out the desirability of using a metalic filter. In general an additional filter of low atomic weight is necessary to remove the soft, secondary radiation of the metal.[7]

The straight line parts of the curves of Figures 3 and 4 are not parallel, but nearly so. This means that filtration by different thicknesses of the same metal changes the penetrating power of the radiation somewhat. The magnitude of this change can be seen from Table II, in the column for the percentage of radiation absorbed by 1 cm. of tissue. Thus, when the filter is ½ mm. of brass, 1 cm. of tissue absorbs 7.7%, while for 3 mm. of lead filtration the corresponding value is 7.1%. The radiation in the latter case is more penetrating than the former. If we increase the filtration considerably, the penetrating power of the radiation can be increased further.

In deep therapy there are two factors which affect the amount of radiation which reaches the tumor: the distance of the tumor from the source of radiation and the absorption of part of the radiation by the intervening layers of tissue. For any one set of conditions, that is, distance of source from skin, strength and distribution of source, and depth of tumor, the quantity of radiation which reaches the tumor depends on the penetrating power of the radiation. The more penetrating the radiation, the more of it will reach the tumor. From this point of view, therefore, it is obvious that it is desirable to use the most penetrating radiation available. This, however, is not the only consideration involved in the problem. When radium is used as the source of radiation, the only means of obtaining a more penetrating radiation is the use of a heavier filter, which of necessity entails a decrease in the amount of the available radiation. Furthermore, the limiting factor in deep therapy is the effect on the skin, since this is always greater than in deep layers, neglecting any difference in susceptibility which may exist between different tissues. Therefore it is important to know what fraction of the radiation which falls on the skin reaches the tumor. The maximum value of this fraction is determined by the relative distances of the skin and tumor from the source. Thus, if a point source of radiation is placed at a distance of 3 cm. from the skin, and the farthest point of the tumor is 3 cm. below the skin, (i.e., 6 cm. from the source) the most that the tumor can receive is ¼ as much as the skin. This is on the assumption, which can never be realized in practice, that the 3 cm. of tissue intervening between the source and the back of the tumor do not absorb any radiation at all. Allowing for the absorption by the tissue of radiation filtered through 1 mm. of brass plus 8 mm. of rubber, we find that the distant parts of the tumor receive 19.9% of the radiation which falls on the skin, instead of 25%. Using a filter of 3 mm. of lead plus 7 mm. of rubber, the radiation at the back of the tumor will increase from 19.9% to 20.2%; that is, it will be 1.5% greater for the same skin dose. This, however, will decrease the intensity of the source of radiation from 6.3% to 4.6%, or 27%, so that in order to obtain the same skin dose using the same amount of radium the duration of the application must be prolonged 27%. The advantage of getting 1.5% more radiation in the tumor may offset the disadvantage of a longer exposure, but, is there any other

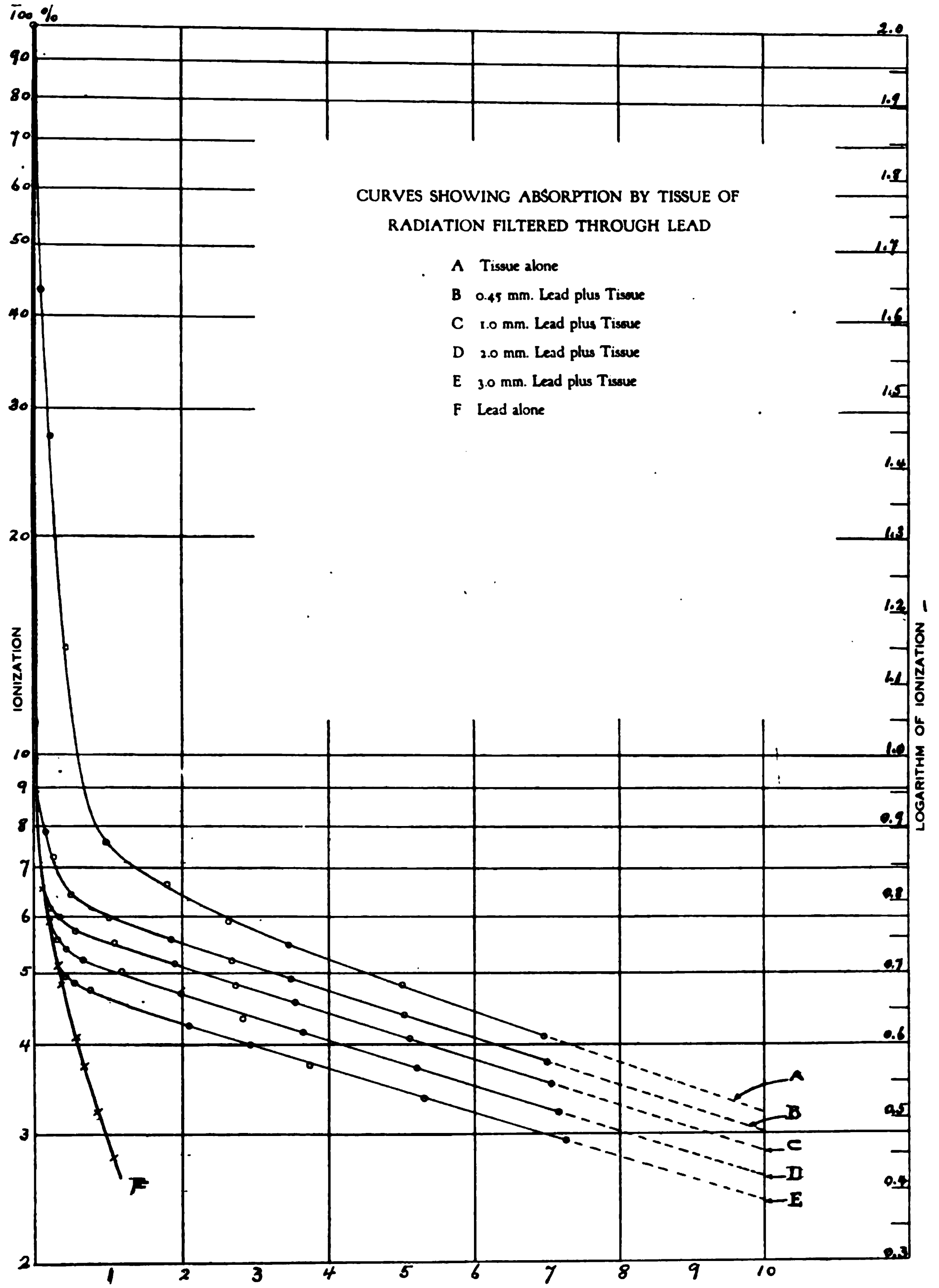
CURVES SHOWING ABSORPTION BY TISSUE OF RADIATION FILTERED THROUGH LEAD
A Tissue alone
B 0.45 mm. Lead plus Tissue
C 1.0 mm. Lead plus Tissue
D 2.0 mm. Lead plus Tissue
E 3.0 mm. Lead plus Tissue
F Lead alone
IONIZATION
LOGARITHM OF IONIZATION
100 %
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1
2
3
4
5
6
7
8
9
10
A
B
C
D
E
F

FIGURE 4.

way of accomplishing the same purpose with greater economy? The relative amount of radiation which reaches the tumor can be increased also by placing the radium at a greater distance from the skin while still using the same filtration as in the first case. Let us determine what this distance should be in order to have 1.5% more radiation in the tumor, that is, 20.2% of the amount reaching the skin. Figure 5 shows the notation used below. The percentage of the skin radiation which reaches the tumor is given by the expression $\frac{100\,x^2}{(x+z)^2} \times e^{-\mu d}$. If this is to be 20.2% when $z = 3$, $\mu = 0.0755$, then $\frac{100\,x^2}{(x+3)^2} \times 0.797 = 20.2$, whence $x = 3.1$ cm. Therefore in this particular case an increase of 0.1 cm. in the distance of the applicator is sufficient to increase the tumor radiation 1.5%. To get the same skin dose the time will now have to be increased in the ratio $\frac{(3.1)^2}{3^2} = 1.068$, or less than 7%. Since in using a higher filtration we found that the time of application had to be increased 27%, it is evident that the same result can be obtained more economically by increasing the distance. This example has been worked out to illustrate this point. In practice, however, an increase of 1.5% would be insignificant. If we had considered the dose at a much greater depth, the effect of a higher filtration would have been larger, and the adjustment in distance to get the same result would have been necessary.

From the law of conservation of energy it follows that, in order to affect the tissue, some of the radiant energy traversing the tissue must be absorbed by it. In fact, as stated in the first part of the paper, there is considerable evidence tending to show that the physiological effect is dependent on the amount of radiation absorbed by the tissue. From this point of view, then, there is an advantage in using radiation which is more easily absorbed by tissue, provided we can obtain the same ratio between the skin dose and the tumor dose, by properly adjusting the distance of the applicator. This simply means that for the same total amount of radiation falling on the skin a given physiological effect can be obtained in a shorter time in the case of the softer radiation. As, however, the time element does not influence the ratio between the skin dose and the deep dose, it will be seen that the fact that tissue absorbs more of the softer radiation does not tend to increase the deep dose in comparison to the skin dose. On the contrary, it is very effective in decreasing the amount of radiation which reaches the deeper layers of tissue.*

In the light of what has just been said, it is reasonable to ask: Can we obtain the same relative dose of radiation at a certain depth of tissue by using *x*-rays and placing the tube at a greater distance from the skin? The answer to this question depends entirely on the quality of the *x*-radiation available. In the example given above it will be seen that the controlling element was the "dispersion" of the radiation and not the absorption. Considering the effect of distance alone, the dose at a depth of 3 cm. was only 25% of the dose on the skin, that is, there was a loss of 75%. On the other hand, the loss due to absorption by 3 cm. of tissue was 20.3%, which is small in comparison. In the case of *x*-rays the conditions are reversed. The target-skin distance probably would not be less than 20 cm. Then for a tissue depth of 3 cm. the dose, neglecting absorption, would be $\frac{(20)^2}{(23)^2}$ or 75.7% of the skin dose. To get the same percentage of the radiation as in the previous case, that is 20%, we can now afford to lose 55.7% through absorption. Using the same equation as before we can determine the degree of penetration which the x-rays must have in order to get at a depth of 3 cm., 20% of the radiation falling on the skin.

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* In working out the above example no account was taken of the above mentioned effect of the quality of the radiation on the time of irradiation. This is justified because the quality of the radiation in the two cases was only slightly different, and under these conditions the ionization method of obtaining the absorption curves used in solving the problem automatically compensates for the difference in the absorption of the two types of radiation.

$x = 20, z = 3 . \frac{100 \times 20^2}{(20 + 3)^2} e^{-3\mu} = 20$. Therefore $\mu = 0.443$. That is, when a homogeneous x-radiation is $\frac{0.443}{0.0775} = 5.87$ times less penetrating than the gamma rays, and the target is at a distance of 20 cm. from the skin, we get at a depth of 3 cm. of tissue 20% of the radiation falling on the skin. If, however, for the purpose of comparison, we place our radium source at a distance of 20 cm. then the dose at a depth of 3 cm. is 60% of the skin dose instead of 20%.* In practice it is desirable to have as little difference as possible between the skin dose and the tumor dose. This condition would obtain if the source were placed at a great distance from the skin; that is, for parallel rays. Then the only factor which limits the radiation at any depth is the absorption. If parallel radiation were used, we would get at a depth of 3 cm. 79.7% of a skin dose in the case of gamma rays, and 26.4% in the case of x-rays six times less penetrating than gamma rays.†

Table I gives the relative amounts of radiation reaching different tissue depths for different conditions of application.

A comparison of columns F, B, and D shows that when the distance of application is increased from 3 cm. to 20 cm., the radiation at a depth of 3 cm. increases from 19.9% to 60.2%, while the theoretical maximum for infinite distance is 79.7%. From this we see that when the distance of application is great in comparison to the tissue depth, further increase in the distance is of little help in increasing the tumor dose. The values in columns F and G show that when the distances are adjusted so as to get the same skin dose and the same tumor dose at a depth of 3 cm., using radiation of different degrees of hardness, the doses are not the same at any other tissue depth, and especially at greater depths than the one for which the

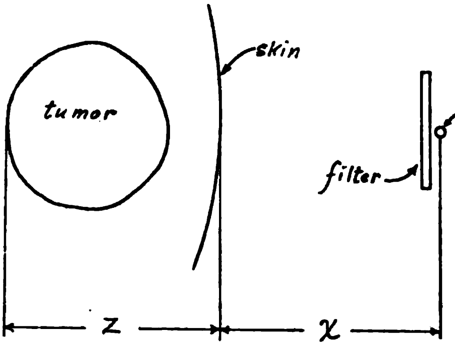

Fig. 5. Diagram showing relative positions of tumor, skin and source of radiation.

TABLE I

A	B	C	D	E	F	G
Tissue depth cm.	*Source 20 cm. from skin*		*Source at infinite distance*		*Ra. 3 cm. from skin*	*Target 20 cm. from skin*
z	Gamma rays $\mu = 0.0755$	X-rays $\mu = 0.443$	Gamma rays $\mu = 0.0755$	X-rays $\mu = 0.443$	Gamma rays $\mu = 0.0755$	X-rays $\mu = 0.443$
0	100	100	100	100	100	100
1	84.2	58.4	92.8	64.3	52.2	58.4
2	71.0	34.0	85.9	41.1	31.0	34.0
3	60.2	20.0	79.7	26.4	**19.9**	**20.0**
4	51.2	11.8	73.9	17.0	13.6	11.8
5	43.8	7.0	68.5	10.9	9.6	7.0
7	32.3	2.5	58.9	4.5	5.3	2.5

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* Whence we see the advantage of using a more penetrating radiation when the conditions of application are the same.

† The filtered x-radiation used at the present time for deep therapy is about twice as penetrating as the x-rays of this example, and less than one third as penetrating as the gamma radiation of radium when the filter is 2 mm. of brass.

doses are the same (3 cm.). The more penetrating radiation "wins out." This may be an advantage or a disadvantage according to the conditions.*

There are some limitations to the applicability of the results so far obtained which should be mentioned at this point. The most important is the effect of the scattered and secondary radiation on the tumor dose. The amount of radiation which reaches the tumor may be divided into two parts (1) that which travels in a straight line from the source to the tumor, and (2) that which reaches the tumor in a roundabout way. The latter is composed of (a) the radiation which is scattered, that is, deflected from its straight line path by the tissue surrounding the tumor, and (b) the secondary radiation which is set up in the tumor by the primary beam. The relative amounts of (1) and (2) depend on the depth of the tumor, the latter becoming more important as the depth increases. The method of measurement adopted for these experiments enables us to measure only the amount of the primary radiation which reaches a certain depth of tissue. The data thus obtained, therefore, enable us to calculate the ***minimum*** amount of radiation which reaches a given tumor under the conditions of application. The upper limit is obtained by neglecting the absorption of radiation by tissue and calculating the effect of distance alone. The actual radiation which reaches a certain depth of tissue is between these two limits. It can be determined by using a different experimental arrangement, which we hope to do in the near future.

Another limitation is imposed by the use of a metallic ionization chamber, as discussed in the first part of the paper. This, however, influences our results only when the quality of the radiation whose absorption we are measuring is changed appreciably in passing through the tissue used as the absorber. As this does not occur in the case of the penetrating radiation used in deep therapy, no error is introduced in using, for this purpose, the data here obtained. But it is not possible to use these absorption curves to determine accurately the beta ray dose for the skin from a knowledge of the gamma ray dose, or vice versa. For instance, if the ionization value of the bare emanation tube is 100%, and for a tube screened by 2 mm. of brass it is 6.7% (Figure 3, curve D), it is not correct to assume that, other conditions being the same, the time of exposure to produce the same superficial effect in the case of the screened tube would be $\frac{100}{6.7}$ or 15 times longer than in the case of the bare tube. The two have to be determined independently by physiological experimentation. The curves enable us to make a first approximation to the doses for various qualities of radiation; the correct values can be obtained by actual trial.

There is another point which requires further elucidation; that is, the significance of the ionization values given in the charts. A given quantity of radium emits radiation in all directions. The amount of radiant energy which passes through a surface of unit area perpendicular to the line of propagation represents the intensity of the radiation at this surface, independently of the quality of the radiation under consideration. But if we attempted to measure this intensity using ordinary ionization methods, the value we would obtain would depend to a great extent on the quality of the radiation. For instance, for beta rays, we could have an ionization chamber in which the gas would absorb all the radiation entering it, but for gamma rays only a fraction of the total radiation would be absorbed. In the latter case, then, we would not be measuring the intensity of the radiation. To take the extreme case, if there were radiation which would not be absorbed at all by matter, then, however strong the source might be, we would never detect it by the means at our disposal, or, in fact, by any other means, if the law of conservation of energy is to hold. For this reason, when we are dealing with radiation of different qualities, and especially of different types, as the beta and gamma rays, we cannot speak of their relative intensities. Therefore the values on the charts are given in percentages of the total ionization produced when the emanation tube has no additional filtration, and they do not represent the intensity of radiation after passing through a filter or tissue or both, but the intensity of ionization which it produces. Accordingly it is not strictly correct to say that the radiation of an emanation tube is decreased from 100% to 6% by a filter of 2 mm. of brass plus 10 mm. of tissue. The radiation, considering the energy which is associated with it, is more than 6%, but this figure indicates the availability of its energy in affecting matter. For our purposes this is not a disadvantage, but an advantage. We are not concerned with the amount of radiation passing through tissue, but with the amount which is capable of influencing vital processes. When the quality of the radiation is not materially changed by the absorber, it is correct to say that the intensity of the radiation is decreased a certain percentage by the absorber. In such cases the factor of proportionality between the energy of the radiation and the amount absorbed remains the same. In addition to the effect of the material of the ionization chamber on the percentage values given for the different thicknesses of absorber, it should be borne in mind that the numerical values depend on the quality of the radiation which is taken as producing 100% ionization. This in turn depends on the wall thickness of the glass tube containing the emanation, which, however, does not affect the relative position of the curves.

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* From the preceding discussion we see that, within certain limits, we can get the same amount of radiation at a given depth of tissue for the same skin dose by using radiation of distinctly different penetrating power, provided the distance of application is suitably chosen. Whether we would get the same physiological effect is a different matter, and one which cannot be determined by physical experiments alone. The question really is whether the physiological effect is independent of the quality of the radiation. At the present time this is not definitely known, but the scanty evidence available in the literature seems to support the conclusion that within certain limits it is independent of the quality.

In Table II, column 5, are given the coefficients of absorption for different metals and different tissues. Little need be added to what has already been said about the absorption by metals. The three coefficients given for lead indicate the change in the quality of the gamma radiation as the thickness of lead increases. In column 4 are shown the range of thicknesses for which the coefficients of absorption were determined. Column 6 shows the half value thickness, that is, the thickness of absorbing material needed to reduce the radiation to one half its initial value. The density (column 7) and the coefficient of absorption divided by the density (the so-called mass absorption coefficient, column 8) are given to show how the absorption varies with the density of the absorber. In column 9 are found the percentages of the radiation absorbed per millimeter of filter corresponding to the absorption coefficients given.

The values in the second part of the table were determined from the curves of Figures 3 and 4. They show the relative change in the absorption of radiation filtered through various thicknesses of lead and brass by beef muscle hardened in 10% formalin. It will be seen that from a filter of ½ mm. of brass to one of 3 mm. of lead the change is $\frac{0.0765 - 0.0709}{0.0765} = 7.3\%$. The mass absorption coefficients have no special significance in this case, and they are not included in the table. It should be noted that the values in column 9 are given for one centimeter of tissue, and not for one millimeter, as in the case of metals.

The values in the third part of the table indicate the relative absorption of the radiation filtered through 1.92 mm. of brass by different tissues. For these experiments fresh organs were obtained. They were cut into as nearly parallel slices as possible, and absorption curves similar to those of Figures 3 and 4 were determined. The experimental work for fresh liver, spleen, muscle, brain, suet, and lung, as well as the formalined muscle, was done continuously, with the same emanation tube in the same position from beginning to end. To make sure that the experimental conditions remained the same throughout, the absorption curve for pure gum rubber was determined at intervals, and used as a check. This also enabled us to include in the table some data obtained on previous occasions. The logarithms of the ionization values for different thicknesses of tissue were plotted to a very large scale and average straight lines drawn, as in the case of Figures 3 and 4. The coefficients of absorption were then determined by reading off two values from the straight lines.

From column 9 we see that the amount of radiation filtered through 1.92 mm. of brass which is absorbed by one centimeter of tissue is not very different for the different kinds of tissue. The two conspicuous exceptions are solid bone, which absorbs almost twice as much radiation as the average, and lung, which absorbs a little more than half as much as the average.

It is often assumed that the absorption of gamma rays is proportional to the density of the absorber. The table enables us to test the accuracy of this assumption. If the absorption were proportional to the density, then all the values in column 8 for the same quality of radiation would be the same. Evidently this is not the case. From physical experiments we know that the mass absorption coefficient (μ/ρ) is the same for substances which have essentially the same chemical composition. As this condition is practically fulfilled by all the soft tissues given in the table, we should expect the values of μ/ρ to be substantially the same. If we stop to analyze the results we find that, within the limits of experimental error this is the case. For lung tissue the value of μ/ρ is considerably lower than the average. The discrepancy, however, can be attributed to the numerous air spaces in this kind of tissue, which are included in the measurement of thickness, but are not included in the determination of the density, since they do not contribute to the volume of the piece of tissue measured by the amount of water displaced. The calculated density, consquently, was too high, and the mass absorption coefficient too low. The smaller difference in the value of μ/ρ for brain may be accounted for in the same way.

The explanation of the low value of μ/ρ for solid bone is based on the results of many physical experiments, which show that the mass absorption coefficient is lower for substances of medium atomic weight than for substances of very low or very high atomic weights.[9] Thus in Table II it is seen that the value for soft tissues, which have essentially the same composition and contain only elements of low atomic weight, are higher than for aluminum or brass, but lower than the first value for lead, which has a very high atomic weight. (The other values for lead are not comparable with the tissue values because the quality of the radiation in the two cases is quite different.) Solid bone, which contains considerable calcium, therefore, approaches aluminum in absorbing power, and for this reason the value of μ/ρ is lower than for soft tissues. "Porous bone," as used in this experiment, consisted of a bony structure having its interstices filled with soft tissue. Theoretically, then, the value of μ/ρ should be higher than for solid bone and lower than for soft tissue. Experimentally it is found that this is the case.

Considering the methods of determining the density of soft tissues, it is reasonable to conclude that, within the limits of experimental error, the mass absorption coefficients for soft tissues are equal. For practical purposes, therefore, we may say that in this case the absorption of gamma rays filtered by 1.92 mm. of brass is proportional to the density of the tissue. This is not the case when tissue is compared with aluminum and brass. For instance, if we know the coefficient of absorption for aluminum and we calculate its value for tissue of density 1.03, in the ratio of the densities, we get $\mu = 0.11 \times \frac{1.03}{2.74} = 0.0413$. But the value experimentally determined is 0.0694, which is 68% higher than the calculated value. On the other hand, the absorption of gamma rays by tissue when calculated from the absorption by pure gum rubber, is correct for practical purposes. $(0.066 \times \frac{1.03}{.97} = 0.070$ instead of $0.069.)$ In the case of solid bone the absorption per centimeter is greater than for aluminum, in spite of the fact that the density of the latter (1.74) is considerably greater than the density of bone (2.01). In radiotherapy it is often assumed that the absorbing power of one centimeter of tissue is the same as that of one millimeter of aluminum. Probably this is true for *x*-rays of a certain quality, but it is very far from the truth in the case of gamma rays.

With the exception of solid bone the tissue which absorbs most radiation absorbs 7.5% per centimeter of thickness. Therefore, if in calculating the amount of radiation which reaches a certain depth, we take the value of

TABLE II

1 *Filter*	2 *Thickness mm.*	3 *Absorber*	4 *Range mm.*	5 *Coef. of Abs. cm.*$^{-1}$	6 H. V. T.* *cm.*	7 *Density*	8 μ/ρ *cm.* $^{-1}$	9 *% abs. per mm.*
Aluminum	6	Aluminum	6-22	0.11	6.3	2.74	0.0402	1.1
Brass	2	Brass	2-22	0.35	1.98	8.26	0.0424	3.5
Lead	2	Lead	2-5	1.01	0.686	11.34	0.0892	10.1
Lead	5	Lead	5-10	0.80	0.866	11.34	0.0705	8.0
Lead	10	Lead	10-15	0.66	1.05	11.34	0.0582	6.6
Lead	15	Lead	15-22	0.58	1.20	11.34	0.0511	5.8
								% abs. per cm.
Tissue	5.00	Formalin Beef Muscle	50-60	0.0815	8.50			8.2
Brass	0.48	Formalin Beef Muscle	10-70	0.0765	9.06			7.7
Brass	0.96	Formalin Beef Muscle	10-70	0.0755	9.18			7.6
Brass	1.92	Formalin Beef Muscle	10-70	0.0752	9.22	1.056	0.0713	7.5
Brass	3.04	Formalin Beef Muscle	10-70	0.0752	9.22			7.5
Lead	0.45	Formalin Beef Muscle	10-70	0.0752	9.22			7.5
Lead	1.0	Formalin Beef Muscle	10-70	0.0736	9.42			7.4
Lead	2.0	Formalin Beef Muscle	10-70	0.0726	9.54			7.3
Lead	3.0	Formalin Beef Muscle	10-70	0.0709	9.77			7.1
Brass	1.92	Solid Bone	3-20	0.13	5.5	2.01	0.063	13.
Brass	1.92	Porous Bone	20-100	0.075	9.3	1.15	0.065	7.5
Brass	1.92	Liver	20-90	0.074	9.4	1.06	0.070	7.4
Brass	1.92	Spleen	20-100	0.073	9.5	1.05	0.070	7.3
Brass	1.92	Muscle	20-100	0.069	10.0	1.03	0.067	6.9
Brass	1.92	Brain	20-100	0.066	10.6	1.03	0.064	6.6
Brass	1.92	Suet	20-100	0.065	10.7	0.94	0.069	6.5
Brass	1.92	Lung	20-70	0.045	15.5	0.78	0.057	4.5
Brass	1.92	Rubber	10-50	0.066	10.5	0.97	0.068	6.6
Brass	1.92	Formalin Beef	20-70	0.075	9.2	1.06	0.071	7.5

*Half Value Thickness

0.075 for the absorption coefficient, we are sure to be on the safe side. It will be seen also for deep radium therapy that the effect of intervening bones on the tumor dose must be small, because the actual thickness of solid bone is small in comparison to the thickness of soft tissues, and the absorption by porous bone is only slightly greater than that of soft tissues. This, however, is not true in the case of *x*-rays, and especially of soft *x*-rays. A convincing proof of this statement is afforded by *x*-ray photographs taken with soft and very hard rays. As for the absorption by human tissue compared to beef tissue, it may be said that in general the former absorbs a little less radiation than the latter. The difference, however, is practically negligible when the same kind of tissue or organ is considered in the two cases. One notable exception is fat, the absorption by human fat being considerably less than the absorption by suet. But in this case the densities are also quite different. The absorption by the fat under the human skin is about two thirds that of an equal layer of the skin proper.

SUMMARY

1. The apparatus used, consisting of a gold leaf electroscope and conical ionization chamber, and the experimental procedure are described in detail.

2. The most important limitations imposed by the experimental method adopted are discussed. They are due to:
(a) Use of a metal ionization chamber.
(b) Use of a gas as the absorbing medium in the ionization chamber.
(c) Exclusion of scattered and secondary radiation produced in tissue.
(d) Inability to reproduce in the physical laboratory physiological conditions.

3. The absorption curves for aluminum, brass, and lead are given. From these we see that:
(a) As the filter increases the transition from soft to hard radiation is quite sharp.
(b) Beyond a thickness of filter of a few millimeters in the case of aluminium and brass the absorption is exponential ($I = I_0 e^{-\mu d}$). In the case of lead it is not exponential in the range of thickness used.
(c) This shows that the filtration by a small thickness of metal is sufficient to give a radiation which is absorbed exponentially by metals of medium or low atomic weight. The radiation, however, is not strictly homogeneous, as indicated by the lead absorption curve.

4. The criterion for the quality of radiation to be used in deep therapy being the exponential absorption of the radiation by tissue, from Figures 3 and 4 we see that:
(a) A metal should be used as the primary filter.
(b) A secondary filter, composed of light elements like tissue, should be used to remove the soft, secondary radiation of the metal.
(c) There are different combinations of primary and secondary filters suitable for deep therapy.
(d) Beyond a certain point additional filtration, while increasing the penetrating power of the radiation slightly, decreases the intensity of the radiation considerably.

5. In deep therapy the limiting factor is the effect on the skin. Therefore it is important to know what fraction of the skin radiation reaches a given depth of tissue. The value of this fraction can be varied within limits by varying the distance of the applicator from the skin, or the filtration.
(a) An example is worked out to show that in the case of gamma rays it is more economical to increase the percentage of the skin radiation which reaches a deep tumor by increasing the distance of the applicator than by increasing the filtration.

(b) A second example shows that, using two sources of radiation of distinctly different penetrating power, we can get the same percentage of a skin dose at a certain depth of tissue in either case by choosing the distance of application properly.

(c) Table I shows that when the distance of the applicator is large in comparison to the tumor depth, the penerating power of the radiation has the greater influence on the tumor dose. (This is the case of *x*-rays.) On the other hand, when the distance of application is about the same as the tumor depth, and the radiation is very penetrating, the distance has the greater influence on the tumor dose. (This is the case of radium therapy.)

(d) The table shows, also, that when the distances are adjusted so as to get the same skin dose and the same dose at a depth of three centimeters, using radiation of different degrees of hardness, the doses are not the same at any other tissue depth, and especially at greater depths than the one for which the doses are the same.

6. The coefficient of absorption is the important factor which identifies radiation. The numerical value depends on the quality of the radiation and on the nature of the absorber. From Table II we see that:

(a) When the same tissue is used as an absorber and the filtration of radium rays is varied in steps from 0.48 mm. of brass to 3 mm. of lead, the coefficient of absorption gradually decreases from 0.0765 to 0.0709. But while the penetrating power of the radiation is increased 7.3% by the additional filtration, the available radiation is decreased 65%.

(b) The same radiation (1.92 mm. brass filter) is absorbed to a different extent by different tissues. For soft tissues the coefficient of absorption is proportional to the density of the tissue.

(c) The absorption by tissue from different organs (except lung tissue, fat, and solid bone) is nearly the same. Therefore if we take 0.075 for the value of the coefficient of absorption of gamma radiation filtered through 1.92 mm. of brass, we are sure to be on the safe side in any calculation we may make for practical use. Corresponding to this value of the absorption coefficient, the thickness of tissue necessary to absorb one half of the radiation is 9¼ centimeters. As a round figure, easy to remember, we may take the half value thickness of human muscle tissue for gamma rays to be ten centimeters.

(d) The presence of bone in the path of the radiation is of no great consequence in regard to the amount of gamma radiation which reaches the tumor beyond it. The only part of the bone which absorbs considerably more than muscle is the solid part. But in any practical case this makes up a small fraction of the total thickness traversed by the radiation. In the case of *x*-rays bone plays a more important part.

7. The results obtained from the experiments described in this paper can be used for the solution of problems in radium therapy, subject to the following limitations:

(a) The calculated amount of radiation reaching any given tissue depth is always the *minimum* amount which will reach this depth under the conditions of application.

(b) Skin doses of beta and gamma radiation are not to be compared according to the ionization values given in Figures 3 and 4. They must be determined independently by physiological experiments.

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PERSONAL EXPERIENCE WITH THE APPLICATION OF THE NEWER ROENTGEN THERAPY IN CANCER*

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THE ideal that every therapy attempts to attain is a complete inhibition and neutralization of the disease, and if possible the maintenance of normal function. Unfortunately excision of a cancer does not prevent further invasion, nor immunize against it, nor does it maintain the functions of the tissue affected. So it is easily conceivable why radiotherapy, even with our former limited knowledge, played such an important part in the treatment of cancer. The fact that recent advances in the technique of radiotherapy have been accomplished abroad makes it apparent that the older methods were found wanting. It is almost needless to say that insufficient penetration of hard rays to the deeper tissues was one of the shortcomings; another was the lack of measurements for practical purposes, and also the lack of knowledge of the exact dosage necessary to influence a carcinoma, a sarcoma or ovary.

Some of these obstacles were overcome by the construction of more powerful apparatus, and also tubes to tolerate higher intensities. The electroscope and iontoquantimeter furnished means of measurement for practical purposes, and with these, the determination of dosage for the destruction of carcinoma and sarcoma were made possible. Apparatus, tubes and technique have been described elsewhere, and need not be mentioned here.

The application of the newer methods of roentgen therapy has led to more gratifying results in the treatment of cancer. Since my return from abroad in the middle of September, owing to the delay in shipping the German apparatus, this improved technique as far as it is applicable to my own apparatus, has been made use of. The following case report is, of course, a preliminary one, and only one of a type has been selected.

One of the first cases selected for this newer therapy was a patient with an inoperable carcinoma of the cervix. She had received a radium treatment three and a half months previous, with no evident arrest of the disease. The malignant process continued, so that when she first came to me, her hemoglobin was 40 per cent, and to all appearances, she was in a beginning state of cachexia. Desirous of trying out the newer technique, she was subjected to the following treatment: a two hour radiation dose on four consecutive days was administered, instead of one session of eight hours, as in Bumm's Clinic. The focal distance used was 50 cm., and the portals of entry 15 by 18 cm. The rays were filtered through 0.5 mm. of zinc, plus 1 mm. of aluminum. In addition 50 mg. of radium element were introduced into the cervix and left there for fifty hours. My aim was to administer what the Germans call a full cancer dose at one session. The reaction was not as severe as those I saw in Germany when the entire treatment was given in one day. The patient gained five pounds in weight within the first week, pain disappeared entirely, and she is at present going about, engaged in her usual activities, free from any clinical manifestations of the disease. A month ago examination of the cervix showed it to be entirely fibrosed.

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Another patient was referred for radiation for recurrent carcinoma in the axilla after radical excision of a carcinoma of the breast. Female, sixty years old, was operated upon for carcinoma of the breast a year and a half ago. Six months later a tumor recurred in the axilla; it was removed again, only to recur within the year. The recurrence, when she reported to me, was the size of half an orange, it was a fluctuating mass of broken-down, necrotic tissue. She suffered much pain, and had to be constantly under the influence of opiates. All in all, she was in pretty bad shape. She also received four radiation doses of two hours each on consecutive days. A dose was directed from front of axilla, one posteriorly into axilla, one from above the shoulder joint, and one from below into the axilla. The focal distance was 50 cm., the filter zinc plus aluminum, and the portals of entry 15 by 18 cm. Four days after completion of the roentgen treatment, 3,000 mg. hours of radium element were placed in the axilla over four areas. A week later the tumor had disappeared entirely, she was free from discomfort, and had left off all narcotics.

In another patient a carcinoma of the breast had recurred over the anterior region of the sternum. The patient was operated upon two and a half years ago for carcinoma of the breast at Mt. Sinai Hospital, had a stormy convalescence, developed erysipelas with abscesses, and had to stay in the hospital for three months. In October last a recurrence of about 12 by 15 cm., the size of the palm of my hand, developed over the sternum extending to the anterior axillary border. Two radiation doses of four hours each, with 70 cm. focal distances, portals of entry 15 by 18 cm., zinc and aluminum filters, were administered. A week later the tumor had receded by half, and in another week the entire tumefaction had disappeared. In this case, about seven weeks ago, a tumor the size of a large lemon made its appearance in the other breast. The surgeon again referred her for radiation, considering her a bad risk for surgical intervention. A full cancer radiation dose was administered, and the tumor has since receded.

These reports are of course only preliminary; the end results may be such, perhaps, as to cause a modification. Furthermore the response in all cases may not be as striking as in these. It is obvious, however, that more intensive radiation than heretofore must be administered along the lines of modern technique. The dosage in this newer technique comprises a more thorough understanding of the biological and physical properties of the rays as they are emitted from the tube, and of the accompanying secondary radiation. The quality of ray, in particular, is one of the most important factors, and of equal importance are the substance and amount of filtration used, the focal distance, and the size of the portals of entry. The proportionate relationship between the radiation energy at the surface of the body, and that of the lesion in the deeper tissues, is called the dosage quotient. This dosage will be most favorably effective in the deeper tissues when we increase the distance of the radiation source, notwithstanding the fact that an increase in the focal distance necessarily increases the time of obtaining a skin erythema dose.

It is well known that with 0.5 or 1 mm. of copper or zinc as a filter, a considerable amount of the energy emitted from the tube is lost. This loss is more than compensated for by the fact that radiation through 0.5 or 1 mm. of copper or zinc produces a more favorable absorption coefficient. In other words rays from this point on will show very little qualitative change, and additional filtration would serve no further purpose.

In addition to the primary rays, the scattered secondary rays materially aid the dosage quotient. For instance, it has been worked out by Friedrich and others, that with 50 cm. focal distance, and a 10 mm. aluminum filter, the primary radiation energy under 6 cm. of tissue would be 22 per cent that of the surface dose; in reality, though, it is increased to 51 per cent by the scattered secondary rays.

CHART I

Filter	*Focal Distance*	*Depth under Surface*	*Estimated Primary Dosage %*	*Actual % with Secondary Rays*
10 mm. Alum.	50 cm.	6 cm.	22. %	51. %
"	50 cm.	8 cm.	13.8%	42. %
"	50 cm.	10 cm.	8.4%	31. %
1 mm. Copper	50 cm.	6 cm.	25. %	67.5%
"	50 cm.	8 cm.	17. %	54. %
"	50 cm.	10 cm.	10. %	44. %

Aside from this increase in the amount of radiation available in the deeper tissues through the proper filtration, the size of the portals of entry must be given consideration. For example, under 10 cm. of tissue, with a portal of entry of 1.5 by 2 cm., the dose is 9 per cent of that received on the surface; with a portal of 6 by 8 cm., however, the amount is increased to 28 per cent, and with portals of 10 by 15 cm., to 35 per cent, and so on. In other words, the larger the portal of entry, the more favorable is the dosage quotient, up to a point of 20 by 20 cm. Any increase in size over this seems to bring no appreciable gain; that is, the intensity of the ray diminishes by dispersion the smaller the portal of entry, and increases in percentage the larger the portal of entry.

CHART II

DOSAGE QUOTIENT IN THE DEEPER TISSUE
(Focal Distance 50 cm.)

Portal of Entry	*Under 10 cm. Tissue*	*Under 3 cm. Tissue*
1.5 x 2 cm.	9%	47%
6 x 8 cm.	28%	66%
10 x 15 cm.	35%	77%

Chaoul, of Sauerbruch's Clinic in Munich, has adopted a very ingenious device of wax blocks, which he calls a "ray concentrator." One set is arranged on either side of the tube, and another at each side of the radiated field, taking in the entire distance between the skin and the tube. In this way he collects or concentrates the rays of dispersion which are then deflected to the center of the field, and thus increases the radiation quotient from 40 to 60 per cent. It becomes essential therefore in order to reach the tumor with the most favorable and suitable dosage quotient, to increase the focal distance, to use filtration of at least 0.5 mm. of copper or zinc, and lastly to use as large a portal of entry as the conditions permit.

Opitz of Freiburg has taken advantage of all these factors which increase the dosage quotient, in the treatment of carcinoma of the uterus, first, by using a focal distance of 50 cm., and second, by enlarging the portal to its maximum of 20 by 20 cm., and by using 1 mm. of copper as a filter. In this manner a skin erythema dose requires about two hours, one application is administered from the abdomen, one from the back, and two from the side. Here also a minor detail of refinement is made use of: the anterior dose is administered so that the centralized ray strikes the left edge of the tumor slightly obliquely, and the posterior dose the right edge of the tumor, in order to prevent damage to the rectum, which is anatomically situated to the left. The sum total of the rays reaching the cancer mass in this manner is very nearly a full cancer dose. To guard against a sublethal dose to the interior of the tumor, a small dose of radium is placed in the uterus. Even if the cancer itself receives slightly more than a knockout dose, the healthy adjacent tissue tolerates this and thus escapes damage.

CHART III

DOSAGE QUOTIENT UNDER THREE CM. OF TISSUE

Portal of Entry	*Focal Distance*	*%*
9 x 12 cm.	30 cm.	74%
10 x 15 cm.	50 cm.	86%
9 x 12 cm.	50 cm.	86%
15 x 15 cm.	80 cm.	90%
9 x 12 cm.	100 cm.	90%
10 x 15 cm.	100 cm.	93%

That intensive radiation for short periods is much more effective than smaller doses for longer periods is pretty generally conceded, and practical use is made of these pathological and biological findings. It holds true also, with small doses frequently repeated, that the period of latency is considerably protracted, and furthermore a cumulative effect may be experienced producing chronic changes which are not at all desirable, either by stimulating the growth itself, or by damaging the healthy tissue. Great stress is laid upon the advisability of administering the entire lethal dose at one sitting. There are, however, times when the entire dose cannot be administered in one day. The condition of the patient or the danger of absorption toxemia may not admit of this. At any rate all efforts should be directed to administering a full lethal dose within a week.

By way of summary I would like to draw special attention to the following points:

It is most essential that sufficient intensive roentgen or radium rays be administered to knock out completely all parts of the cancer without damaging or destroying adjacent healthy tissue. If any one part of the tumor receives a sublethal dose, failure and recurrence is sure to follow.

To effect the most favorable conditions of radiation to the deeper tissues, proper filtration, increase in the focal distance, and increase in the size of the portals of entry must be made use of.

The determination of correct dosage comprises knowledge of the clinical location of the tumor, its pathology, radiation dosage quotient, and absorption coefficient.

From the personal application of this technique in this short period of time, I gain the impression that raying in the form of a complete knockout dose administered at one time will bring about better results in cancer therapy.

CLINICAL RESULTS FROM THE NEWER TECHNIQUE OF DEEP ROENTGENTHERAPY IN MALIGNANT DISEASES

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

DURING September, 1920, Drs. Coolidge and Schmitz brought back to us from Germany the information that in Germany a greater amount of filtration was being used in the treatment of deep-seated malignant disease, with the source of rays at a greater distance from the skin and with the use of a higher voltage. The impression of the few men who had the privilege of visiting the German clinics was that more satisfactory results were obtained from this technique than from the lighter technique used in this country. Our equipment in America did not permit an exact duplication of the technique used in Germany because our apparatus as built to-day will not generate current at a voltage greater than 125,000, or at most 130,000. It seemed important, therefore, to see whether the technique could be improved with our present apparatus and then perhaps later to determine whether the results obtained by such improvement would correspond to the results obtained in Germany. It is always desirable to proceed from the known to the unknown, and instead of jumping wildly from one technique into another of unknown quantity and unknown value, I proceeded by calculations to transform my former technique for deep roentgentherapy into my present technique. Generally my former technique consisted of 5 milliamperes of current at 126,000 volts, at a focal skin distance of 20 cm. filtered through 6 millimeters of aluminum, for a period of 8 minutes. My present technique consists of the use of 5 milliamperes at 126,000 volts, filtered through 10 millimeters of aluminum or glass, at a focal skin distance of 30 cm., for a period of forty to fifty minutes. I find that forty minutes will rarely give an erythema, and that fifty minutes will generally give an erythema. This technique has been developed gradually, in part by calculations and in part by experimentation.

I would like to add a caution at the beginning of this article and repeat it again at the end: it is most important in every instance before the current is turned on that the filters be counted to make sure they are in place, because if filtration is deficient this prolonged treatment will produce an incurable burn. As a precaution against an accident I require that two people make observations on the filters for every dose given. If the equipment is arranged for deep treatment only, so that this one uniform technique is used continually for all kinds of cases, then the filters can be permanently put in place and the precaution of counting will not be necessary, but in the general roentgenological laboratory the apparatus must be used for different purposes and 10 millimeters of filter is not always desirable, because it wastes energy unnecessarily.

RELATIVE VALUE OF FILTERS

In order that our technique be made understandable it is necessary to know the relative value of various filters. Several years ago, at one of these midwinter meetings of this Society, I recommended the use of glass instead of aluminum because the metal filters frequently led to puncture of the Coolidge tubes. From a scale furnished by the Radium Chemical Company of Pittsburgh, I observed that glass had approximately the same filter value as aluminum. Therefore by using glass we obtained a filter less likely to lead

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*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 28, 29, 1921.

to punctures of the tubes and that serves equally well for filters. For this purpose the ordinary glass used for photographic negatives was cut to the proper size. First of all we made a direct comparison of many layers of this glass and in our own laboratory found it to be uniform. I am told by Professor Shearer that glass is not uniform in its density, and therefore I caution others against the use of glass until it has been compared carefully with aluminum or some other standard, after which I believe that it can be used safely. For this purpose we took 10 millimeters of aluminum and 10 millimeters of glass and with the current such as is used for treatment above described we were able to prove that, at least so far as the photographic values are concerned, the two are equal. The exposures were made of 1/8, 1/4, 1/2, 3/4 and 1 second. In order to form some idea of the relative value of filters such as are used in Germany I then made a comparison photographically of copper and aluminum. In Germany, as you will recall, they are using from 1/2 to 1 millimeter of copper as a filter. By my experiments I learn that 1/2 millimeter of copper is equal to 13 millimeters of aluminum measured photographically.

With the above technique and with exposures lasting from forty to fifty minutes (and in a few cases I have given sixty minutes), it is self-evident that it is undesirable from every standpoint to limit our field of radiation to small areas such as we have been doing in the past. I think most of us have gradually increased the size of the field of exposure. When we consider that the smaller the field of radiation, the less the amount of secondary radiation, and since we must acknowledge that the secondary radiation probably does as much as the primary radiation towards destroying malignant disease, and in fact may be the sole cause of destruction of the malignant cells, the relative value of small areas and much cross-firing decreases. It is always desirable to cross-fire as much as possible providing we are actually cross-firing, but mere division of the surface of the body into small areas, as I have often seen done, does not actually increase the cross-fire value. For example, in the treatment of carcinoma of the uterus, it is my practice to treat the local disease directly by radium and then to cross-fire through an area extending from the symphysis pubis to the umbilicus and to the anterior superior spines on each side, and either use this as one area for treatment or divide it into two. Then a similar dose is given through each lateral surface of the pelvis and one or two similar areas posteriorly. In this way all parts of the pelvis are irradiated and I have seen some most brilliant results. For example, a patient referred to me on September 30, 1920, by Dr. Wm. R. Nicholson, was considered by him totally inoperable. The entire cervix, including the walls of the upper part of the vagina, were involved by the carcinoma, making a total area of malignant disease 7 or 8 cm. in diameter. She received 4200 milligram hours of radium treatment locally and two courses of *x*-ray treatment consisting of four areas in each course during six weeks. At the end of two and a half months all evidence of disease had disappeared. Even in recurrent disease about the pelvis, with the above technique I have obtained results that I have never seen equalled by my former technique. In recurrent and metastatic disease of the breast and in primary disease of the breast I have seen results which are far superior to those obtained by my former technique. In a few primary cases that for some reason were considered inoperable, I have seen all palpable evidence of malignant disease of the breast including recurrent and metastatic nodules, disappear more rapidly and more satisfactorily than formerly. I have also seen recurrent nodules disappear that gave no response to the technique formerly used.

I think all of us have made the observation in the treatment of malignant disease that unless a pronounced primary effect is obtained and the disease made to disappear within a few months, it often develops a resistance which is as great as that of the surrounding tissues, and therefore it requires an amount of treatment necessary to destroy the malignant disease such as will also destroy the surrounding healthy tissue. I believe, therefore, that it is desirable in all instances to get as much treatment into the malignant disease within the first month or two as can be borne by the healthy tissues, and in this way the malignant disease is destroyed while it is yet more sensitive to radiation than the healthy tissue. For this reason I dislike treating a patient who has been inefficiently treated for several months and then referred to me because the disease has made progress.

Another phase of this newer deep roentgen therapy that cannot be ignored refers to the radiation sickness. Those who give small and frequent doses are less concerned about the radiation sickness. There is, however, nothing magical in anyone's technique with regard to radiation sickness. It is probably a measure of the amount of radiation and the reaction of the tissues and the nervous system therefrom. Those who give little radiation will therefore have little radiation sickness. We immediately found, therefore, that as we increased the length of our exposures we also increased the radiation sickness, both in frequency and degree. We are hoping, by careful study of the subject, to learn how to overcome this condition; but for the present an increase of the interval between the treatments or doses given has been found to be our best safeguard. One cannot, however, I believe, obtain the same results by too much division of dosage; and if we use this deeper technique and at the same time attempt to give it in fractional doses, the expense thereof will be correspondingly increased, and unless most carefully managed may allow the cancer cells to mature and develop a greater resistance to the rays. As it is, the expense of giving a dose of the deeper therapy is greatly increased as compared with the former technique. One must, therefore, keep the practical side in mind until more powerful equipment is developed and some means found of reducing the expense due not so much to apparatus, electricity, etc., as to human service.

With increase in the length of exposure one also encounters the increased danger of stray radiation and secondary radiation. Therefore greater precautions are necessary to guard against leaking tube shields, or any other form of stray radiation. As a step in this direction, I have designed the protecting device previously described.[1] If more powerful apparatus is developed we must also keep in mind that with increased power comes increased danger, which necessarily calls for increased precautions.

I believe the technique above described to be a definite advance. It will probably be further modified and further developed, but so far it is adaptable to our present outfits, and if used with great caution greater beneficial results can be obtained. I think we may draw the following conclusions at present:

1. Increased filtration, with increased focal skin distance, will increase the value of deep radiation as compared to the surface effect.

2. By increasing the above two factors the time of radiation is greatly increased—probably five-fold. This prolonged radiation in itself may be an important factor in preventing cell division and regeneration of the cancer cells.

3. Radiation sickness is increased, and extra effort must be made to overcome this effect.

4. The greatest caution must be observed in keeping the filters in place and at their full prescribed quantity.

5. Increased protection is necessary for both the patient and the operator.

6. The clinical results obtained from this new deeper technique excel those obtained formerly.

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[1] A New Device for Increasing the Protection of Both the Patient and the Roentgenologist. Presented before the Philadelphia Roentgen Society January 13, 1921, and THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 20, 1921.

A NEW DEVICE FOR INCREASING THE PROTECTION OF BOTH THE PATIENT AND THE ROENTGENOLOGIST*

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

WITH the increase of power in our exciting apparatus there has been a progressive increase in dangers to both the patient and the roentgenologist. These dangers consist primarily of injuries from the high tension current to either patient or roentgenologist, and secondarily and more insidiously the dangers from stray radiation. With the death of one physician and two patients during the past two years from accidental contact with the high tension circuit it is incumbent upon us to utilize every means possible to eliminate such possibilities; and while the device which is here described briefly and illustrated more particularly may not give absolute security, it surely does give increased protection. It is important to see, of course, that there are no loose wires or any that are likely to become loose; but there still remains the possibility that during an examination a patient may bring some part of his body within sparking distance of the high tension current, and we know that when the arc once starts through the air, which ordinarily is an insulator, but which then becomes a conductor, a large amount of current can easily flow into the patient, and the results above referred to indicate the danger.

The danger from stray radiation to both the patient and the operator has increased with the increased voltage and filtration. While these stray rays are never as strong as those applied directly to the part being treated, as we increase the time of exposure (which increases with the amount of filtration), any escape of stray rays through the opening in the glass shields becomes a serious danger to both patient and roentgenologist; and while the roentgenologist is farther away than the patient, he is exposed to these stray rays over so much longer period of time that they become a danger to him. For instance, most of us who are now using 5 milliamperes of current and 9 inch parallel spark gap, can give an erythema dose of unfiltered rays in approximately one minute at a distance of 8 inches. With increased filtration to 10 millimeters of aluminum and increased distance to 12 inches the time is increased to as much as fifty minutes and therefore, even though only one-tenth or one-hundredth as much radiation comes through the opening in the glass bowl as is passed through the opening in the diaphragm, it becomes a serious danger to both the patient and the operator.

As a step towards overcoming these dangers above described, I have made use of opaque rubber which contains approximately 25 per cent of lead and which has an insulating value equivalent to a 4 inch spark. That is, it will force a spark to leap around the edge for a distance of 12 inches before puncturing the rubber. But since the distance from the terminal of the tube to the top of the rubber is only 8 inches the actual insulation value is only about 4 inches, because the current tends to creep along the rubber to about one half the air spark resistance. The rubber is about 3 millimeters thick, and is sold as Hercules red rubber packing. A piece of this rubber, 12 inches by 18 inches, is attached to the base of the diaphragm and is then curved over the ends

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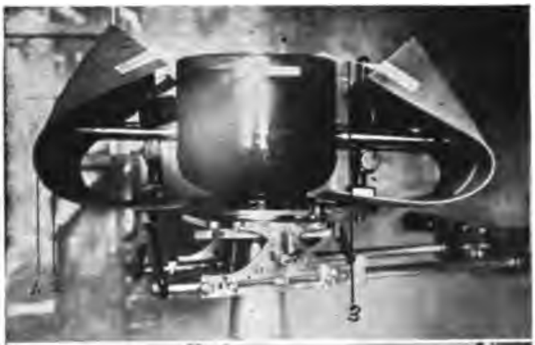
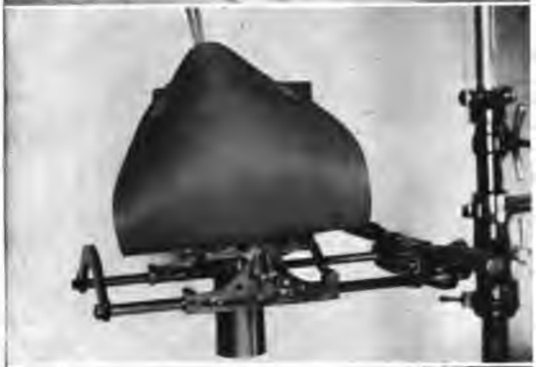
*Read at the Philadelphia Roentgen Society, January 13, 1921, and at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 28, 29, 1921.





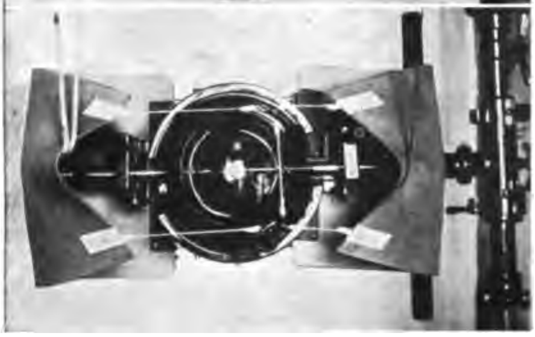


Fig. A (*above*). Lateral View, showing the opaque lead rubber curved about the ends of the tube and closing off the line of radiation through the openings in the tube. (1) The opaque rubber. (2) Reinforcement layer. (3) Springs and hooks holding the top of the lead rubber together across the top of the lead glass shield.

Fig. B (*middle*). Front view of protective shield.

Fig. C (*below*). Top view of protective shield.

of the tubes and the wires, and is folded back towards the glass bowl so as to cover both the front and the back and at the same time to carry the wires upward 8 inches. The central portion of this rubber directly in front of the terminals of the tube is reinforced by another thickness of this rubber, 6 inches by 6 inches, which increases the insulation and increases the protection against the roentgen ray. The upper ends of this rubber are fastened together by cords and small hooks so that they can be easily released when it is necessary to change the tube. The changing of tubes is fortunately not so frequent as was necessary with the old type of gas tube, and therefore the inconvenience of making these connections is of secondary importance. This rubber protection can be adapted to any type of tube holder. At least, we have adapted it to six different types used in our laboratory and while I am only illustrating one, a little ingenuity on the part of the roentgenologist or a mechanic will enable him to adapt the device to anyone's use. The photographs have been made in three different views and I think illustrate the attachment and application better than I can do by description. On one tube stand we have found an advantage in extending the cords over a cross-piece resting on two posts which fit over the rim of the glass bowl or shield. This carries the support higher and makes the tension less upon the terminals of the tube.

This protecting device moves easily with the tube holder and glass shield and is no inconvenience. While it does not give absolute protection either against the high tension electric current, or the radiation, it is a good step in the right direction.

X-RAY TREATMENT OF PULMONARY TUBERCULOSIS*

By WILL WILKINSON, M.D.

PHOENIX, ARIZONA

FOR the past decade *x*-ray men have been the cavalry of the great and splendid army of medical men, and I appreciate the honor of being made a member of a society all of whom are imbued with the "let's go" spirit.

It occurred to me that in one respect I am treading in the path of my illustrious confrère and fellow-townsman, Dr. Warner Watkins, who usually starts something whenever he appears before you. It is a little surprising that *x*-ray therapy is a recognized treatment for glandular, bone, skin and peritoneal tuberculosis, but has been so little applied in chronic lung trouble. The substernal lymph glands are usually the primary foci of infection, and the arrest of the disease is complete or partial in proportion to the fibrosis and calcification of chest lymph glands. Careful workers have very generally reported success in the treatment of tuberculous cervical glands. Why not give tuberculous bronchial glands the same treatment?

The proven value of the *x*-rays in unresolved pneumonia has established its place in the treatment of this disease of the chest. Furthermore, it is admitted that it is the actinic rays of the sun that are responsible for the brilliant results of solar therapy in all forms of tuberculous infection. Also we now know that the sun's rays are physically the same as *x*-rays, only much softer. I believe the greater penetration of *x*-rays makes them especially valuable in the treatment of deep-seated tuberculous foci in the lungs, and that we are really putting sunshine inside the chest.

Dr. J. D. Gibson, of Denver, was one of the pioneers in *x*-ray therapy; he gives this remedy the foremost place in the complete arrest of his own lung disease some twenty years ago. Since that time he has had a very large clinical experience with *x*-rays in office treatment of consumptives. After being in general practice in Phoenix, where about half my work was with tuberculous patients, I had the opportunity of visiting Dr. Gibson. He showed me a large number of chest plates of his patients, and, with few exceptions, the cases that persisted in the treatment showed marked reduction in the substernal gland shadows. As I went over his case records and interviewed his patients, I was convinced that they improved in appetite, weight and strength much more rapidly than my own tuberculous patients, or those of any practitioner with whose work I was familiar.

In a recent article, Dr. Gibson says: "The fact is, the *x*-ray is probably the greatest blessing ever bestowed in one agent upon suffering humanity through the medical profession. *X*-ray diagnosis has saved its thousands, but radiotherapy when properly recognized will save its millions. It has a range of therapeutic effect from producing the gentle stimulation with slight hyperemia, on to over-stimulation and inhibition, until destruction of tissues results."

Again, from the same paper: "I made the claim many years ago that the opsonic index should be controlled and regulated by means of the *x*-ray. Dr. Crane, of Kalamazoo, and Dr. McCullough, of London, have sustained this contention. Later, I ascertained that with the hyperemia and engorgement produced in tissues by means of the *x*-ray, changes developed in the tissues which had for their final effect the creation of homologous vaccine from the antigens developed within the patients' own tissues. These vaccines, antitoxins and antibodies, generated in Nature's own way, give us a most ideal autogenous vaccine."

Other writers have called attention to the improvement in lung trouble when only the cervical glands were being rayed, and attributed the benefit to autogenous vaccination from the cervical glands. Dr. Gibson gives a series of blood counts made on a number of cases which show a decided increase in the mononuclear cells.

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*Read before the joint meeting of the Pacific Coast Roentgen Ray Society and the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY, at Avalon, Catalina Island, California, June 19, 1920.

A very interesting paper, entitled "Experimental Studies with Small Doses of *X*-Ray," appeared in the *Lancet* of April 26, 1919. Dr. Russ and his coworkers studied their effects upon the blood and found the mononuclears more markedly affected than the reds or polynuclears. I quote at some length his results:

"We have obtained identical results upon the lymphocytes with unscreened medium *x*-rays and with very hard rays screened by 7 mm. of aluminum.

"From the results of many experiments devised to determine the nature of the action of the *x*-rays on the lymphocytes, it has been concluded that the action is a direct one upon these cells in circulation. One such experiment was as follows:

"A rat completely screened by lead except for a region over the heart, was exposed to a parallel beam of *x*-rays; the exposure was adjusted so that the circulating blood should receive the same amount of *x*-rays as it would by exposing the whole animal for about one minute. The fall and recovery curves of the lymphocytes were obtained and charted. They were nearly identical.

"The fact that the lymphocytes disappear from the circulation in such large numbers after an exposure lasting but two seconds leads us to doubt very strongly that this is due to their destruction, especially as they reappear with great rapidity. It is not a direct local effect of the radiation upon the tissues, for no local accumulation occurs in the irradiated area, nor have we detected any alteration in the general distribution of the lymphocytes through the lungs, liver or kidneys, as they have been examined from this point of view.

"If lymphocytes *in vitro* be given a dose one thousand times as large as that required for these effects *in vivo,* no degenerative changes are detectable microscopically and no diminution in their numbers is observed.

"A rat, when given a small dose of *x*-rays (twelve seconds) shows a 50 per cent reduction of its circulating lymphocytes one hour later; then it begins to recover and in twenty-four or forty-eight hours is normal again. If the same dose is administered a fortnight later, a similar drop occurs, the recovery is slightly delayed, but the numbers of lymphocytes finally reached is generally greater than at the beginning. Repeated application of such a small dose may result in a high degree of lymphocytosis. The circulating lymphocytes in the two cases depicted have increased from 11,000 and 25,000 to 112,000 and 117,000 per cm. respectively; corresponding counts for the polynuclear leucocytes were initially 5,000 and 5,000, terminating in 10,000 and 14,000 per cm. respectively.

"There is clear evidence of instability in the blood contents of these irradiated animals, but the number of lymphocytes rarely drops so low as the normal level, even several months after the exposures have ceased.

"Exactly what are the best radiation conditions for the production of this lymphocytosis it is not yet possible to say. Large doses may eventually produce the condition, but are to be avoided, owing to their injurious nature. It is uncertain, at present, whether a small dose repeated at very short intervals produces the result. One batch of eleven animals was given small daily doses (twelve seconds) over a period of two months. The average of the lymphocyte counts before irradiation was 19,000; three days after the last dose of *x*-rays, it was 27,000, and no marked rise was detected later, although counts were made upon some of the animals for another two months.

"It has been shown in a previous publication by two of us that when sarcoma cells (Jensen's rat sarcoma) are inoculated into rats which had been previously immunized, the failure of the sarcoma to grow is associated with some special activity on the part of the lymphocytes.

"The further experimental fact acquired

was that if immune rats were given a dose of *x*-rays sufficiently large to cause and maintain a marked lymphopenia, then such immune animals became once more susceptible to the growth of the sarcoma."

X-ray workers have become sterile, and we are able to induce the menopause and sterility in women, whenever indicated. It may be that the reproductive power of the tubercle bacillus is reduced by the Gibson method of *x*-ray treatment and its virulence destroyed.

During the past seven years, I have been treating consumptives with *x*-rays and most of them were decidedly benefited. I have also had a good success in relieving winter coughs which would not respond to cough mixtures. Three to six exposures on alternate days are usually sufficient in these cases.

As an illustration, I cite the case of a young mining engineer who for four years after coming to Arizona did not improve greatly and was unable to work. In the fall of 1913, I gave him a three months' course of *x*-ray treatment. There was marked improvement in cough, and pulse dropped to eighty; by early spring he went to work and has not lost much time since. Last fall and winter he took another course of treatment, of five months' duration, with decided benefit in his general condition. The radiographs of his chest showed marked increase in peribronchial fibrosis, with scattered areas of calcification and diminution in the width of the hilus shadow.

TECHNIQUE

We give treatments three times a week, alternately exposing the anterior and the posterior chest, using 2 to 3 ma., 6 in. spark, 15 in. distance, 5 to 10 minutes time, and 3 mm. of aluminum as filter. In many cases, we begin with a dose somewhat less than the above, especially if the case has rapid heart and slight temperature, applying the lesson taught by heliotherapy, that the tuberculous patient must begin with very short sun baths.

To sum up, we believe that when *x*-ray therapy is properly used in incipient tuberculosis, especially with those who have improved or are at a standstill, most of them will be decidedly benefited. As in pneumonia, inflammation and congestion are relieved, adhesions are absorbed to some extent, lymphocytes are increased, infected lymph glands become shriveled and cease to be foci of infection. Fibrosis and calcification are promoted, the pulse rate is lowered, and the blood pressure approaches normal. With the improved circulation and elimination, patients sleep and eat better and gain in weight. Expectoration becomes at first freer and then thinner and gradually decreases. The cases progress toward complete arrest much more rapidly than they would without the *x*-ray therapy.

Later, we hope to be able to report a series of cases with blood and *x*-ray findings before, during and after courses of *x*-ray treatments.

[NOTE. The technique we are now using is 5 ma., 9 s. g., 15 in Tg. Sk. and 3 to 6 minutes time, according to temperature reaction of patient. We do not want more of a reaction than that of a light vaccination. This dose is given two or three times a week, alternately anteriorly and posteriorly.]

A ROENTGEN STUDY OF DUST INHALATION IN THE GRANITE INDUSTRY*

By D. C. JARVIS, M.D.

BARRE, VERMONT

BARRE, Vermont, being the largest granite center in the world, the opportunity to study granite dust inhalation is exceptional. A permanent residence in Barre rules out the time factor and makes it possible to carry the work to any conclusion thought advisable. Practicing eye, ear, nose and throat for the past twelve years among granite cutters, one's attention could not fail to be focused sooner or later on their respiratory troubles, and becoming interested in the problem a hospital transformer was purchased in 1917 for office use in the hope that with its assistance some knowledge might be gained of the chest condition of these men.

INTRODUCTION

The accumulation of cases was slow and the advent of The National Tuberculosis Association in the field during 1919 was welcomed. Through its Committee on Mortality from Tuberculosis in the Dusty Trades, an investigation of the granite industry was started, because it was thought that the granite industry of all the dusty trades would show the highest mortality from tuberculosis. The investigation was divided into three phases: a statistical inquiry, a mechanical process inquiry, and the medical examinations. Dr. Edward R. Baldwin of Saranac Lake is chairman of the medical work, and the writer wishes at this time to acknowledge his unfailing encouragement and helpful guidance which has made this work possible, for there are many things to be done in an investigation of this kind before 1240 men are interested and vote to appear for the actual work. Through the trying preliminaries when the work hung in the balance Dr. Baldwin's assistance was invaluable. The writer owes a debt of gratitude to Dr. Kennon Dunham for blazing the trail, as his work saved much valuable time, labor and worry. Without Prof. William Snow Miller's work on anatomy of the lungs, which was at hand for reference and study, some of the observations recorded would have been impossible. The granite cutters have shown a remarkable spirit of cooperation. They did not appear because of any illness, but came up for examination in routine order by previous arrangement. Many of them had never had occasion to consult a physician before. They were all able to work and considered themselves in good health. As the work progressed serial films of these men were suggested and from the helpfulness received from the few cases studied serially it seems advisable to extend the serial idea to a greater number. Ten years will probably be consumed before conclusions can be drawn, so at this time a preliminary report is presented on the 386 men thus far examined. This number have all been taken stereoscopically, and it is planned to continue the examinations until 1,000 have been examined

Nature of Report.—There are so many points worthy of detailed discussion that at this time only a survey of the general factors influencing the appearance of the films will be considered. As soon as possible separate studies of the apices, annular shadows, mediastinum, heart shadow, hilus, diaphragm, and Dunham's fans will be reported, but in the present paper only a general development of the lung lesion will be considered.

REVIEW OF LITERATURE

Roentgenological.—In this country at least very little seems to have been done in systematically investigating a dusty trade by means of the roentgen ray. The work at Barre[1] represents the first work of the Committee on Mortality from Tuberculosis in the Dusty Trades. The only other investigation is represented by the valuable contribution to be found in *United States Health Bulletin No. 85,* issued January, 1917, comprising *A Clinical Study of 433 Cases of Miners' Consumption among Zinc Miners in Southwestern Missouri,* by A. J. Lanza, with a chapter on Roentgen Ray Findings in 150 Cases, by Dr. Samuel B. Childs of Denver. In THE AMERICAN JOURNAL OF ROENTGENOLOGY for June, 1917, Dr. W. W. Boardman reported three cases dealing with dust inhalation. After a thorough search of the literature he comments on the fact that it seems to be remarkably free from any discussion of this subject. He states that in the standard works on clinical medicine there was no reference to the roentgenographic appearance of the lungs in dust inhalation except in Barker's article in *Monographic Medicine* in which a brief reference was made. He states that the text books on roentgenography consulted were all silent except Robert Knox and Rieder. He was able to find only one journal article, and that by a German writer who reported five cases. In 1918, in the March number of THE AMERICAN JOURNAL OF ROENTGENOLOGY, Pancoast, Miller and Landis reported 137 cases gathered from eight industries. Abroad one finds *The General Report of the Miners' Phthisis Prevention Committee of South Africa,* published under date of March 15, 1916. In this report of 189 pages only three and one half are devoted to a report of the 8,000 radiographic examinations made. It is not stated whether the exposures were made stereoscopically or not. The work of Collis[2] in England devotes very little space to the roentgenographic phase, being more in the nature of a statistical study.

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*Read by invitation at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., September 14-17, 1920.

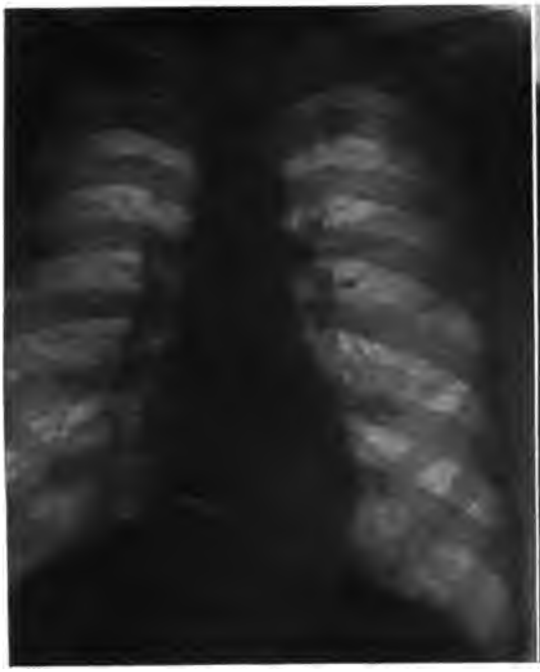

Fig. 1 (130). Exposure eighteen years. Granite Pneumoconiosis stage B. Notice peribronchial thickening which is so common in granite cutters with complete absence of constitutional symptoms.

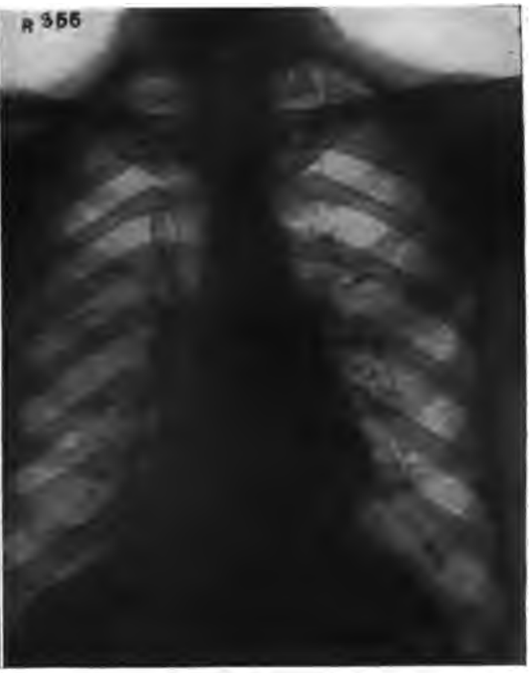

Fig. 2 (355). Exposure eighteen years. Granite Pneumoconiosis stage C.

Pathological.—The South African *Report* states that "it is important to understand the distribution of the lymphatic channels since it is by their means that dust particles which have been conveyed into the lung are distributed through the organ." Intermediate silicosis may be defined as a diffuse fibrosis due to the gradual accumulation of mineral particles in the lymphatic capillaries as a result of chronic obstruction of the lymphatic circulation. Dr. LeRoy Gardner of Saranac Lake Laboratory is in charge of the pathological work connected with the investigation and the following extract is from his paper read before The National Tuberculosis Association at its annual meeting in 1920:

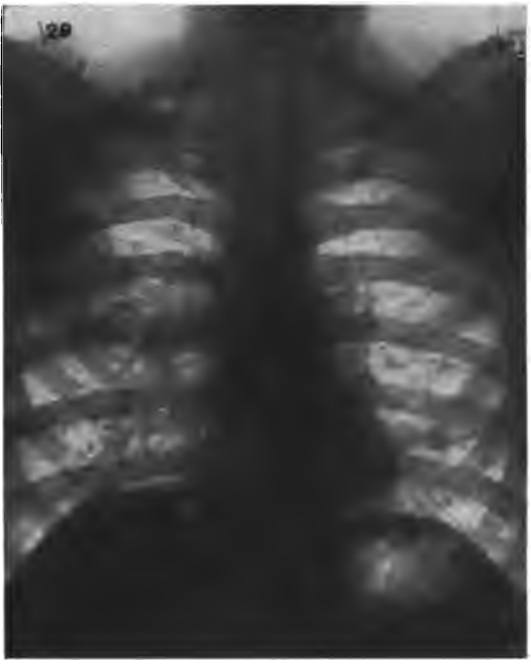

Fig. 3 (129). Granite fibroid pneumoconiosis stage A. Exposure twenty-five years.

"In guinea pigs after about three weeks' exposure small amounts of dust may be found enclosed in mononuclear intro-alveolar cells which often show mitotic figures. These cells are scattered everywhere in the alveoli from the pleura to the hilum. At about two months some of these intra-alveolar cells have begun to mobilize and have formed considerable collections of cells often so closely packed as to simulate giant cells. These cell masses lie in the alveoli along the course of the ductuli alveolares and about and within the small lymphoid collections occurring in the periphery of the lungs. As Miller has shown, such collections occur at the distal ends of the ductuli alveolares and at the division points of the vessels. Dust has already passed through the lung and lodged in small amounts in the tracheo-bronchial lymphatics. From three to seven months the same process continues with a steady increase in the amount of dust deposit. The invasion of the lymphoid tissue of the lung is more extensive and the larger nodules at the bifurcation of the bronchioles and bronchi become involved. All of the lymphoid tissue of the lung becomes very active and mitotic figures are very common even in the normally small peripheral collections. If the animal be set aside after dust exposure the lung makes rapid and effective effort to rid itself of the irritant. The clearing process has only been observed up to three months in animals dusted for seven months previously, but at that time practically all the dust is collected within large aggregations of round or oval mononuclear cells which lie in the immediate vicinity of much enlarged lymph nodules. Heavy deposits occur within such nodules and within the tracheo-bronchial lymph nodes.

Composition of Barre Granite:

Silicon Dioxide	69.56
Aluminum Oxide	15.38
Iron Oxide	2.65
Magnesia Oxide	Trace
Calcium Oxide	1.76
Sodium Oxide	5.38
Potassium Oxide	4.31
Manganese	Trace
Loss on ignition, CO_2 and moisture	1.02
	100.06

"According to Gardner[4] when examined under the microscope the unscreened dust may be roughly divided into large and small particles. The former, which could not possibly be concerned in an inhalation experiment,

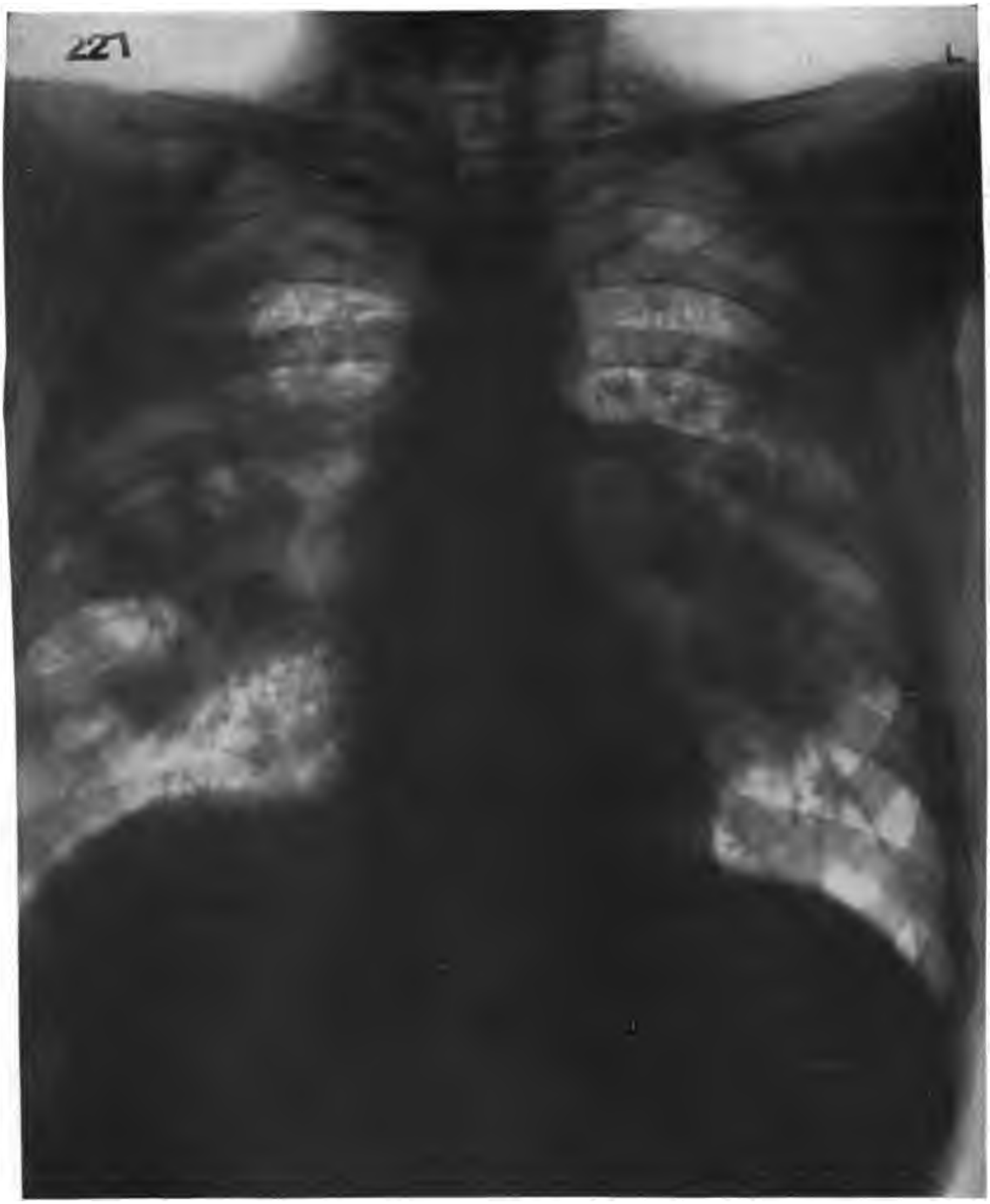

Fig. 4 (227). Exposure thirty-three years. Working every day. Granite fibroid pneumoconiosis stage C. Only symptoms slight cough, slight expectoration. Physical examination negative.

show an average size of 82 by 84 microns (ocular micrometer measurement). The smaller particles average 4.3 by 6.3 microns with a minimum of .028 by 1.4 microns by actual measurement. In shape the particles may vary greatly. Some are flattened polygonal masses with sharply cut edges and corners. Others are rod-shaped, often slightly curved, with sharply horizontal or square cut ends. Frequent vegetable cells and fibers are noted."

Samples of dust resulting from the use of the pneumatic tool have been examined by means of a small giant magnet made by the Victor *X*-Ray Corporation, and considerable steel has been extracted from a given quantity by means of the magnet, 2 drams of granite dust yielding 2 grains of steel. From this experiment it will be seen that we are dealing with two kinds of dust, that from the stone being worked and that from the tool used in working it, giving rise not only to a silicosis but to a siderosis as well.

PRESENT PROBLEM

In 1915, we find in Barre 2,050 granite cutters working, while in 1919 we find only 1240. The question suggesting itself whether this condition was peculiar to Barre alone, the total number of cutters for the United States was investigated and it was found that there was a corresponding diminution in the number of cutters throughout the whole country. For a number of years before the war immigration showed a decrease, and for the same number of years the number of entering apprentices was also very small. The statistician returned the report that an analysis of the death certificates for the past twenty years in Washington County indicated that 86 per cent of the cutters died from tuberculosis. The roentgen ray study was undertaken to assist in determining the incidence of tuberculosis among living cutters.

Technique.—It was annoying to develop the films of the cutters taken during the day only to find that there was such a variation in the quality. Exposures were made basing the changes in technique upon the difference in weight that the men presented, but this necessitated so much attention to the details of developing, offsetting over-exposure in some instances and under-exposure in others, that it was finally decided to make every factor constant except that of time, and a detailed set of measurements was instituted in order to discover if possible a measurement or measurements upon which exposure time might be based. Measurements were taken as follows: From the fifth dorsal vertebra by means of a pelvimeter to a corresponding point upon the sternum, from the left nipple to a corresponding point upon the scapula, from the sixth rib in the axilla to a corresponding point in the opposite axilla. These measurements were entered in the appropriate columns and with them the weight and height. The films were then developed in Eastman developer, using standard time and temperature, and the results noted. Two hundred and thirty-five sets were necessary before the table was worked out, and the day's work showed uniform quality regardless of weight or height. At first thought it was felt that the measurement through that part of the chest representing lung area would be the most satisfactory, but with the complete data at hand whenever the fifth-dorsal-to-sternum measurement coincided in the day's work the films showed the same quality, but when other measurements coincided the quality varied greatly. By means of a pelvimeter the chest expansion was watched in the areas representing the original measurements and it was found that the spine-to-sternum measurement changed very little, while the variation of the scapula-to-nipple measurement was influenced by the position of arms and inspiration. Consequently the fifth-dorsal-to-sternum measurement was adopted as the basis of estimating the patient's exposure time. These cutters were a splendid type physically, and while the table has been worked out on these muscular men it still holds good for the patients coming in the ordinary office practice. The technique is as follows:

Spark Gap—3½ inches.

Coolidge 30 M. A. Tube run at exactly 30 M. A., the hand being on the tube rheostat constantly during the exposure to make any adjustment needed at once.
Distance from tube target to film using upright stereoscopic shift 30 inches.
Developer time 5 minutes.
Temperature of Eastman developer 66° F.

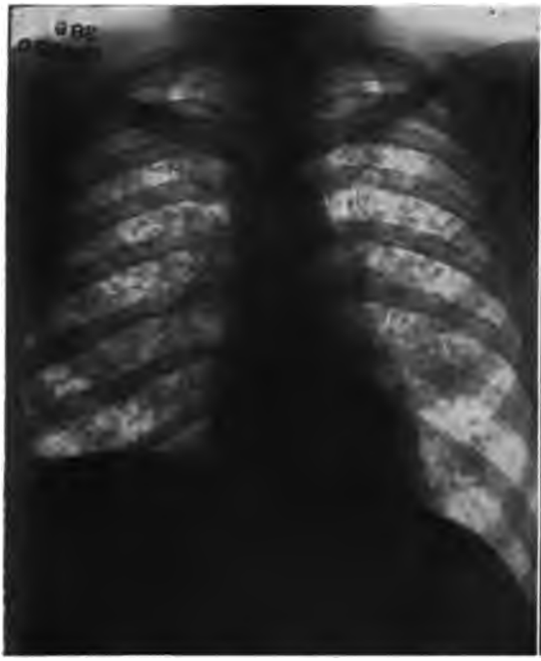

Fig. 5 (389). Fifty-two years of age, working every day. Exposure twenty-eight years. A professional swimmer, his last race being at age of thirty years, and the distance one mile. Sputum negative. Physical examination negative. No symptoms.

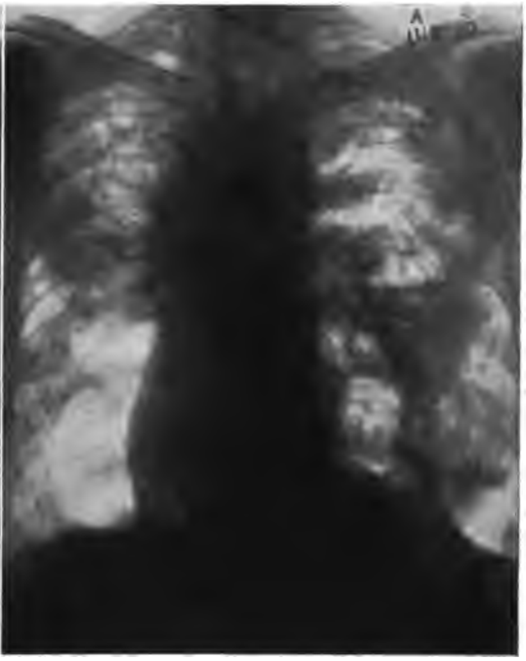

Fig. 6 (A.S.—11-5-20). Exposure fifty years. Repeated examination of sputum negative. Marked dullness all over base. Deficient breathing. Scattered bronchi.

Using the above constants the following measurements and time produced results:

FIFTH-DORSAL-TO-STERNUM

	Time by Time-Switch
6 inches	1½ seconds
6½ inches	2 seconds
7 inches	2½ seconds
7½ inches	3 seconds
8 inches	3½ seconds
8½ inches	4 seconds
9 inches	4½ seconds
9½ inches	5 seconds

In estimating the point upon the spine through which to pass the principal ray of the second exposure the lung is percussed down to absolute dullness on the back and the junction of the lower third with the middle third selected as the point for the passing of the principal ray of the second exposure. The tube stand is then elevated as usual for the first exposure. To avoid the clavicle in the apical region the suggestion of Dr. Bray of Raybrook Sanatorium has been adopted, namely, that of having the hips grasped between the thumb and forefinger of each hand and the shoulders thrown forward without elevation against the stereo shift. The patient is given a toy noise-maker such as is used when showing lantern slides, and is directed to signal as taught by Mr. Sampson of Trudeau Sanatorium when patient has taken a moderately deep breath and is ready to cooperate by holding it during the time necessary to secure both views of the stereo set. Patient signals when told that operator is all ready and is not allowed to breathe between the exposures of the stereoscopic set.

Classification of Films.—An effort was made to prove that these men had tuberculosis, but not being able to do this it was found necessary to accept the diagnosis of pneumoconiosis, and a continued study of the films seems to bear out this diagnosis. A classification being more or less imperative in order that the films be studied systematically the following was decided upon:

Granite Pneumoconiosis Stage A
Granite Pneumoconiosis Stage B
Granite Pneumoconiosis Stage C
Granite Fibroid Pneumoconiosis Stage A
Granite Fibroid Pneumoconiosis Stage B
Granite Fibroid Pneumoconiosis Stage C
Granite Tuberculous Pneumoconiosis Stage A
Granite Tuberculous Pneumoconiosis Stage B
Granite Tuberculous Pneumoconiosis Stage C

It seems advisable to use the term Pneumoconiosis, as the two Greek words from which it is derived signify Lung Dust, which really represents the condition being studied, while the term Phthisis is apt to convey as many meanings as it has pronounciations. While the term Silicosis has been used it seems advisable in the interest of efficiency to use the term Pneumoconiosis and in connection with the qualifying adjective Granite, as the term Granite Pneumoconiosis suggests at once the nature of the lung lesion under consideration, the manufacturing process, percentage of silicon dioxide in the dust and the type of workman. The second classification, Granite Fibroid Pneumoconiosis, suggests not only the nature of the lung lesion and the industry in which it occurs but also the progress which the lesion has made. The third classification, Granite Tuberculous Pneumoconiosis, suggests the causative factor in producing the original lung lesion, the industry responsible for the lesion and the fact that tuberculosis has been superimposed upon pneumoconiosis. Taking up the various subdivisions under each main classification we first consider "Stage A" under the classification "Granite Pneumoconiosis." The films coming under this have a hilus density easily discernible and linear markings going to the first and second interspaces and increased perivascular markings in the bases. It is found that even outside of the industry the Barre residents examined as controls fall into this class as we have a dust hazard in the general atmosphere of the town, "Stage B" includes films that show linear markings radiating in all directions from the hilus to every part of the lung reaching almost to the periphery. "Stage C" in addition to the above shows a homogenous haziness over each lung between the linear markings. Under the classification "Granite Fibroid Pneumoconiosis Stage A" are included films showing a fibroid area not larger than 3 centimeters. "Stage B" films showing a fibroid area not larger than 6 centimeters, and "Stage C" films showing fibroid areas larger than 6 centimeters in their longest diameter. The classification "Granite Tuberculous Pneumoconiosis Stage A" represents minimal tuberculosis, "Stage B" moderately advanced and "Stage C" far advanced tuberculosis superimposed on granite pneumoconiosis.

Dust Exposure Periods of Men Examined.—The length of time that granite dust had been inhaled was represented by four months in one cutter and the maximum time by fifty years in another.

FACTORS INFLUENCING THE APPEARANCE OF THE FILMS

Mouth Breathing as a Factor.—It was most perplexing to find cutters with equal number of exposure years and working under the same conditions showing such marked differences in the appearance of the films. It became quite evident that given the number of exposure-years one could not even hazard a shrewd guess with any degree of success as to the probable appearance of the *x*-ray film. According to the experience of Watt, Irving Johnson and Steuart[5] the mouth-breather is more apt to develop silicosis than one who employs nasal respiration. Particular interest has been taken in keeping detailed data of the upper part of the respiratory tract, hoping to show the influence the nose and throat played in the developing of pneumoconiosis. All this data will be reported at another time, but it is sufficient to say that the defensive mechanism of the upper respiratory tract breaks down fairly early in granite dust inhalation. An adaptation of the upper resipratory tract to occupation takes place, an anesthesia of the tract developing as evidenced by the inability of a cutter to feel a pencil point when drawn across his pharynx. One may hold a throat mirror in viewing the larynx for an indefinite length of time, the cutter stating that he feels nothing in his throat. In view of these facts one wonders how efficient the cilia are, and with the sensory nerve endings of the trachea and bronchi anesthetized by adaptation to occupation there is absence of cough of irritation, thus encouraging the dust to remain in the lungs. Particular attention has been paid to noticing whether the men coughed while undergoing the examination work connected with the x-ray phase, and one could not fail to observe the almost entire absence of coughing among the men. The films belonging to the cutters showing mouth-breathing were separated from those showing nasal breathing, and a study was made comparing them with other films of the same exposure-period, with the result that one cannot help but observe that the films belonging to the mouth-breathers show a lesser lung lesion than nasal breathers. The explanation is that the usual curve of the inspired air is broken by mouth-breathing and the dust impinging upon the posterior pharyngeal wall is expectorated as soon as the accumulation warrants it, or is swallowed, with the result that very little of it reaches the trachea and the lungs are consequently spared.

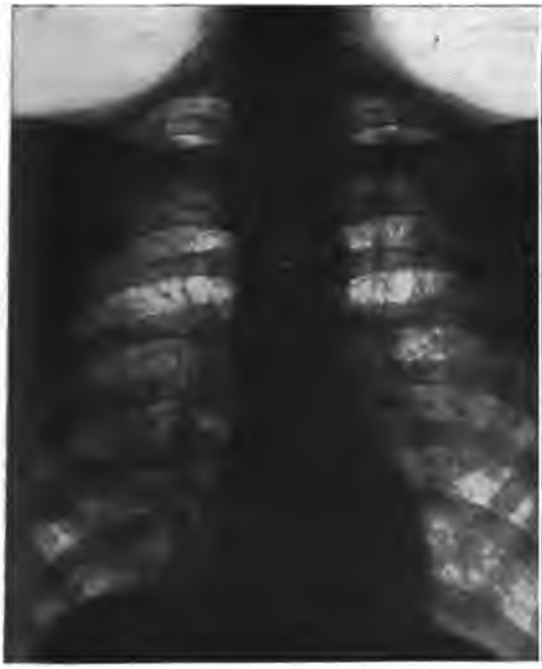

Fig. 7 (185). Exposure thirty years. Ambidextrous. Even lesion both sides of chest.

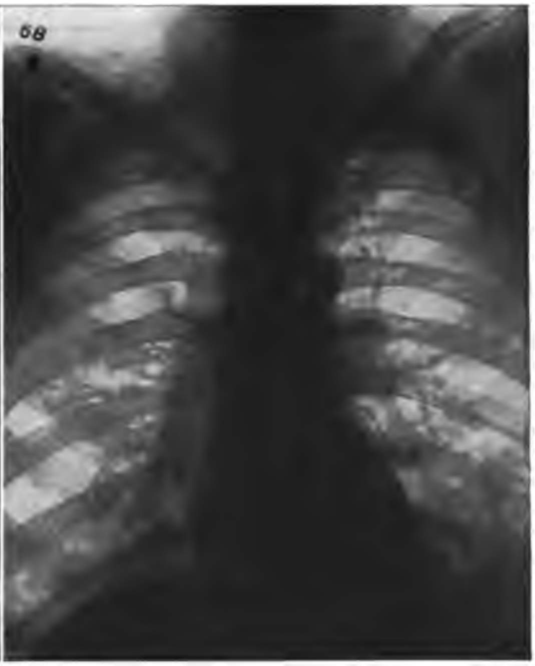

Fig. 8 (58). Exposure twenty-seven years. Showing basal condition starting in left base. Notice calcification of ribs so common in cutters.

Nationality as a Factor.—It was noticed while looking over an accumulation of films representing several days' work that a fairly large number of them showed less density than the others. This seemed strange because the cutters appearing for examination during the three-day period represented were all men with an advanced exposure history. Laying the better films aside and referring to the examination blanks it was discovered that the majority of these films were those belonging to Italians. It being felt that the constant viewing of films had blurred one's ability to appreciate different densities, the films were taken to a granite manufacturer with the request that he look them over and lay aside those showing less white in the lung field, paying no attention to shadows which represented the heart, ribs, etc. To my surprise his collection of films which he designated as better contained those of the Italians. Ten nationalities are represented in the examination work and the films were now studied from this angle with the result that they were found to line up somewhat as follows in order of excellence: Italians, Americans, English, Spaniards, Scotch, Swedes, Norwiegans, Danes, French and Irish. You will notice that there is a geographical distribution of these races, many of the better ones living in Southern Europe and many of those along the last of the list living in Northern Europe. They may be also classified on the basis of those living in dusty countries and those living in countries not so dusty. It cannot be denied that in the granite industry at least the Irish are punished severely, and it is a question whether they should be in a dusty trade—certainly not in the granite industry, as they represent a hazard under the present working conditions and should not be accepted as apprentices. In looking about for an explanation of the difference in susceptibility of the different nationalities one has a feeling that in the chests of the Italians the dust is filtered out so rapidly that it never is other than an irritant, while in the Irish for example it passes the irritant stage and becomes a foreign body.

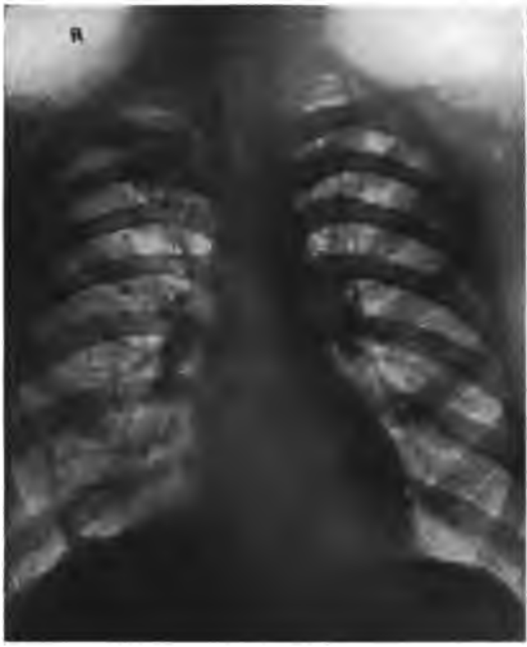

Fig. 9 (177). Exposure fifteen years. Showing right basal condition just starting.

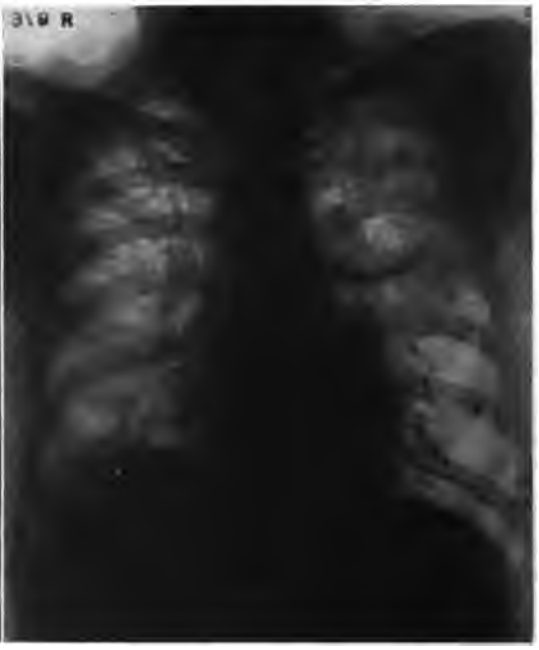

Fig. 10 (750). Right basal condition farther advanced. Exposure thirty years. Patient died two months later. Death occurred suddenly during night. Cardinal symptom was dyspnea.

Occupational Position as a Factor.—In studying the films two areas always showed an increase in density in linear markings in earlier stages, and as the lung lesion advanced this difference in density held good up to the point where the whole lung area on both sides was involved. These areas of increased density were represented by the portion of the lung field just below the left clavicle and at the right base. In endeavoring to explain this increased density in these situations the occupational position of the men was studied and it was found that the pneumatic tool they use vibrates 3,200 times a minute, and in order to secure a basal support that the tool might be used to the best advantage the upper part of the right chest is compressed by the right arm and elbow and the lower part of the left chest is compressed by the left elbow and forearm. This apparently limits the respiratory action of the portions of the chest, and palpation of the same at work shows limited expansion in the compressed areas thus allowing more dust to find a resting place in that portion of the lung receiving most air. It has been stated by other observers that the progress of the lung lesion was greater on the right side below the clavicle, but the experience in Barre would lead one to suspect that the occupational position of the workers examined was different from that of the granite cutters. It would seem, then, that occupational position is a factor in determining the part of the lung in which a lung lesion from inhalation of granite dust has its inception.

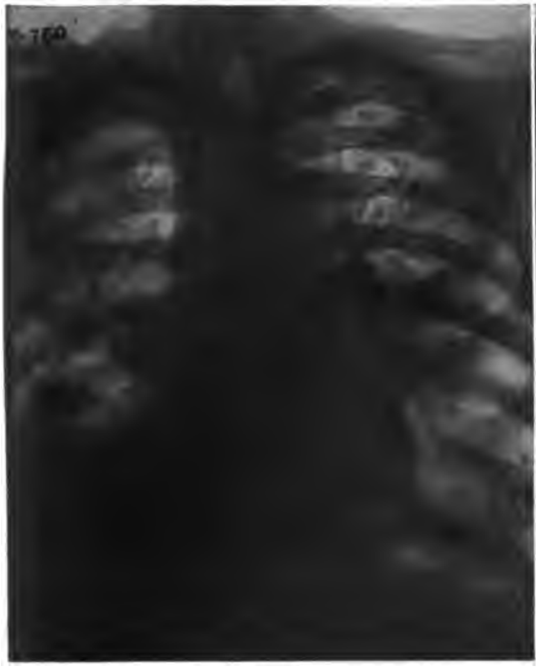

Fig. 11 (319). Exposure thirty-two years. Showing progress of right basal condition. No symptoms.

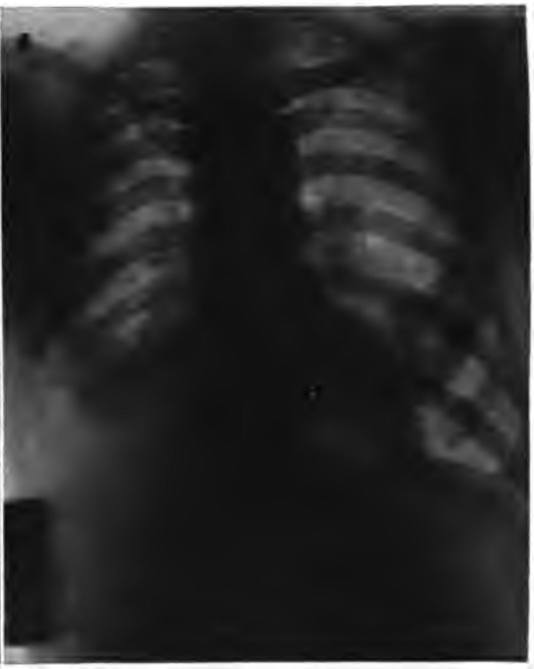

Fig. 12 (270). Exposure thirty-five years. Taken September 8, 1919. Notice right basal condition.

EVIDENCE GAINED FROM NON-SERIAL FILMS

In a work of this kind one must of necessity study non-serial films, because it takes a cutter thirty years to produce a lung lesion which would be diagnosed if he had constitutional symptoms as lobar pneumonia. It takes him between twenty and twenty-five years to produce a lung lesion which would be diagnosed as broncho-pneumonia if he had constitutional symptoms. It is manifestly impossible to follow an individual cutter by means of serial films through thirty years of granite dust inhalation. For labor turnover, the migratory nature of the cutter and the ever recurring strikes necessitating his seeking employment in other industries for the time being at least, and from which he often fails to return if the occupational environment is congenial, are conditions incompatible with serial films extending over

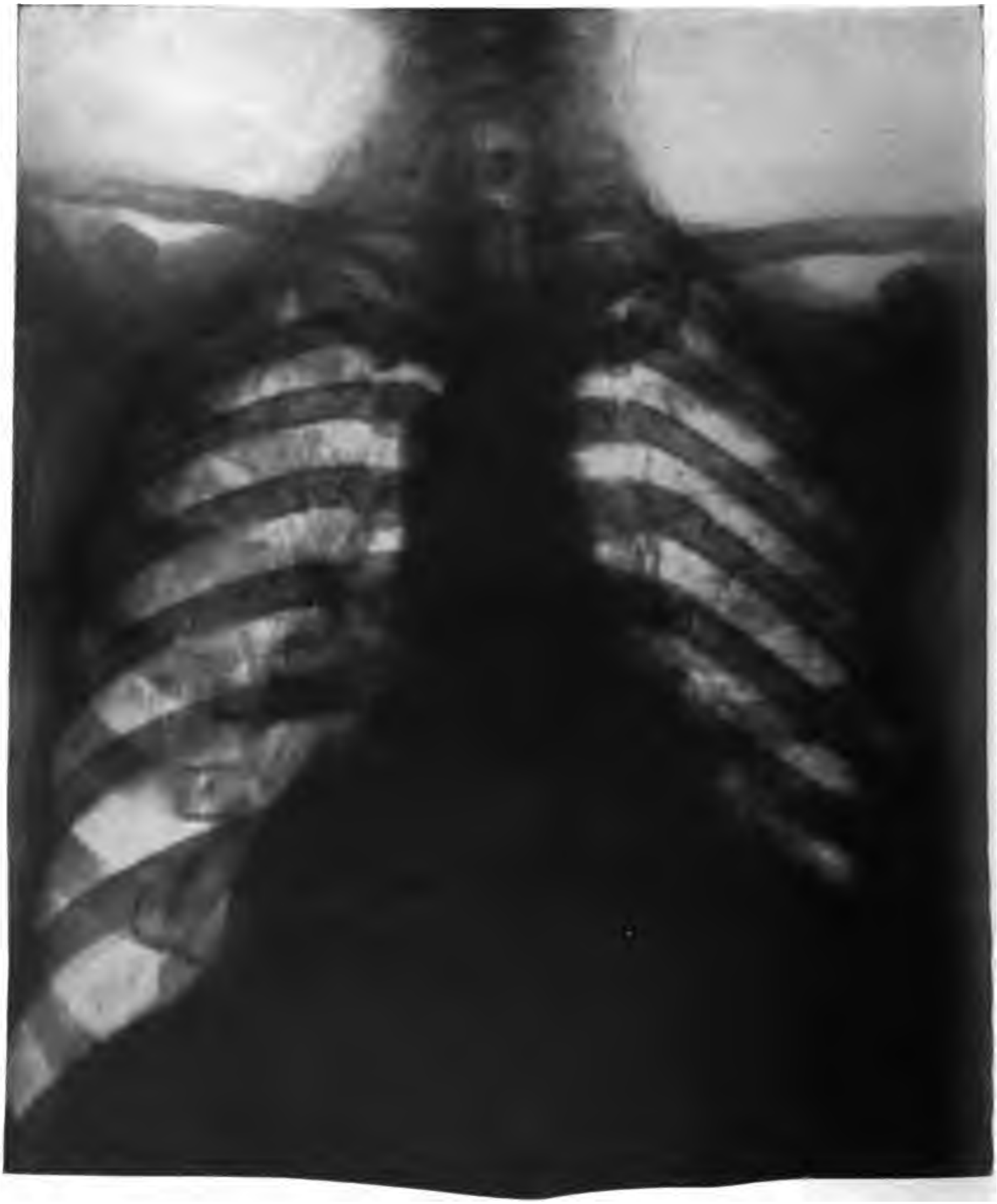

Fig. 13 (No. 160). Same patient as Fig. 12. Taken after two months' absence from granite industry. Note change in appearance of right base.

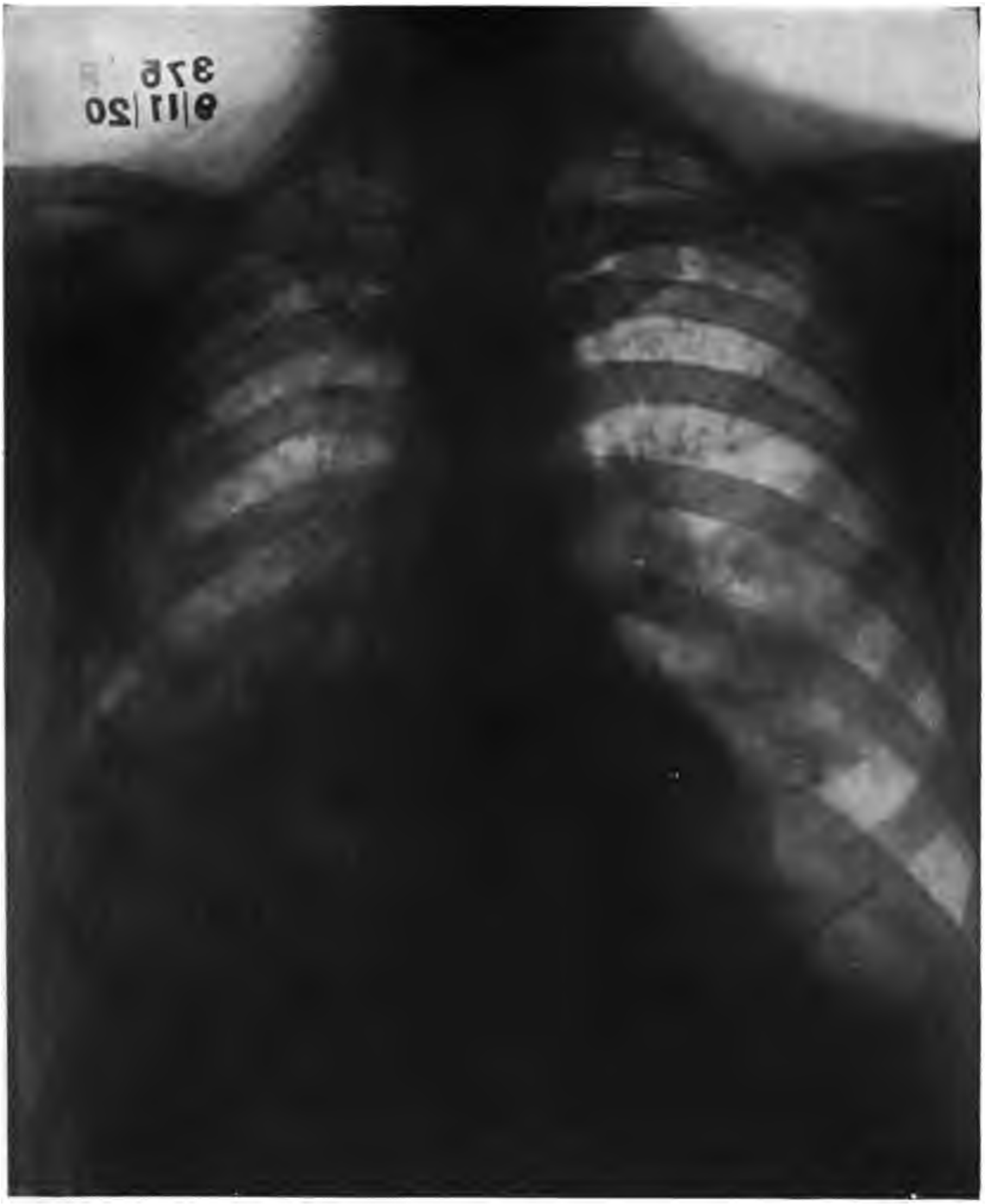

Fig. 14 (375). Same patient as Figs. 12 and 13 Taken five months after re-entering granite industry. Notice reappearance of right basal condition, on exposure again to dust.

any period of time. An effort is being made to select men who for various reasons will be expected to retain a permanent residence in Barre and take them serially, so that in the same individual the lung lesion may be traced from stage to stage. It is hoped to continue this until at least the pathological process observed in one cutter overlaps that seen in another. In the few instances where it has been possible to observe the lung lesion by means of serial films of the same cutter, the evidence has borne out the inferences made by studying several hundred non-serial films.

It is quite evident from this study why it is impossible to describe a normal or standard hilus. It would be as difficult as to describe a normal day or a normal reading of an outside thermometer. We learn to vary our sense of normal with the changing seasons of the year. In like manner we learn to vary our sense of normal so far as a hilus is concerned as the respiratory environment of the individual changes. A normal hilus for a granite worker is never seen because his intake of dust is changing from week to week, especially if he is experienced enough in the work to be an all-around man. If he is he uses varying processes of creating the finished product, depending upon the process he is detailed to for the time being. So one does not try after a while to describe a normal hilus, but rather looks upon the hilus as his lung indicator, telling what has gone on before and what is now going on. The hilus then represents the peripheral reception of the irritant, and in the case of the granite cutter it is a mechanical one with no ability to proliferate and no ability to produce toxic products for absorption with their production of constitutional symptoms.

The pathology seems to be the same whether the irritant is mechanical or bacterial, only in case it is bacterial the lung lesion is accelerated so that in a few days or a year at most results are produced that it takes years to produce with a mechanical irritant. In proportion to the amount of dust that is brought to the periphery of the lung by way of aspiration, in like proportion will the hilus show a change in increased area and density. On this point we feel sure, because we have seen in the same cutter the hilus diminish in size because the cutter was obliged to loaf owing to a severe eye injury, and on his return to the industry we have seen the hilus increase to the original size when inhalation of dust was resumed. With the hilus the lymph node nearest the hilus underwent a change, emptying during the loafing period and taking on its function and reappearing upon the film when work was resumed. These observations lead us to believe that the extension of the lesion is not from the hilus outward *per se,* but rather that the lesion is peripheral all the time, and the hilus change as to speed shows us how great the peripheral severity is.

As the hilus continues to act as an indicator of the dust brought to the tracheobronchial lymph nodes by the lymphatic system of the lungs, there comes a time when the first set of lymph nodes external to the hilus take on their function, being visible to the eye on the film as the cervical lymph nodes are palpable when they take on their function. As the study extends we are able to make out three sets of these nodes from hilus to periphery. For the sake of description these lymph nodes have been called "proximal set," "medial set" and "distal set." Now using one of these proximal lymph nodules, as we shall call them, for an apex of a triangular area, we shall find the base formed by two medial nodules of the same character. In turn using one of these medial nodules for an apex we shall again see the base of a triangular area formed by two lymph nodes, but this time they will be those of the distal set. The sides of these triangles are formed by linear densities.

From these triangular areas which at first contain the lung markings seen in the lung as a whole, we see Dunham's fans develop. If one is at all skeptical about the occurrence of Dunham's fans he will soon have that skepticism removed if he studies the films of pneumoconiosis of a number of workers, for they are seen unilateral, bilateral and in almost any part of the lung. The right lung from apex to base seems to be able to accommodate five at one time with the bases to the pleura and the apices to the hilus in all except the lowest, which has its apex pointing toward the diaphragm. If one lays aside all of the films having a fan in the same area and then studies them the evolution of one of these fans will be watched until it occupies practically the entire upper left lobe with a stem extending back to the hilus as large around as a pencil. One has a feeling as the linear markings are studied that they are perivascular rather than peribronchial, because in cutters exposed for twenty years and then out of the industry for a period greater than five years, the bronchial twigs can be made out as an area of lesser density to the inner side of the linear markings. The inner boundary of the bronchial twig is seen as a thin white line, but there is no area of greater density accompanying it. These bronchial twigs can be followed quite a distance out into the lung structure. In regard to what is spoken of as peribronchial thickening we have seen it change during the ten weeks' strike in 1920, becoming lessened in width and irregular in border as the dust deposit was unevenly moved on to the hilus.

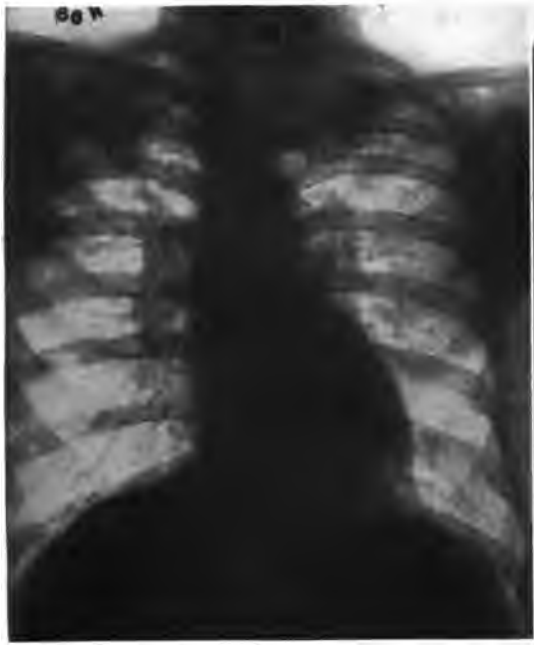

Fig. 15 (166). Exposure twenty-eight years. Bilateral Dunham's fans each involving first interspace trunk both sides.

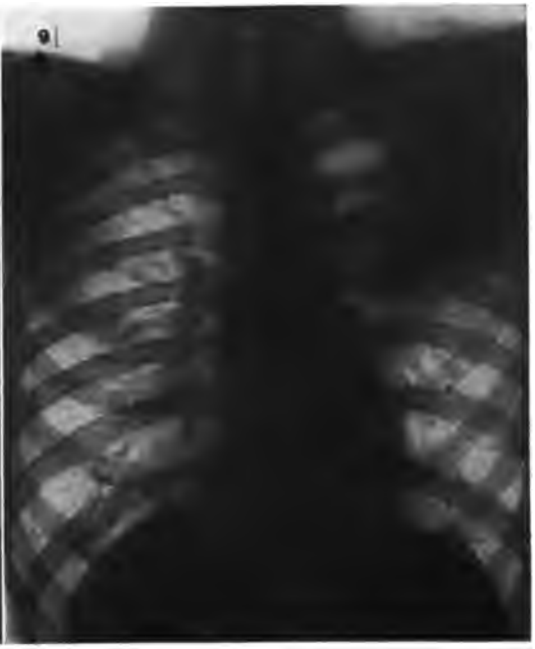

Fig. 16 (91). Exposure twenty-six years. Stage 5 of one of Dunham's fans. Note the pleural detour.

Considering the lung lesion as it affects the proximal medial and distal sets of lymph nodules described, we first notice the proximal node appearing when the hilus has increased in width, reaching near this nodule. At first this nodule looks like the end of a cotton wound applicator and is adjacent to a bronchus on end. From its size of about six mm. in diameter it increases until it takes on the appearance of a tuft of absorbent cotton, its edges being blurred and irregular, the original density being perceived near the center as an area of slight increase in density over the surrounding area. About the time this is 2 centimeters in width the medial node appears and undergoes a change similar to that of the proximal node. In turn the distal node appears, and as it undergoes its increase in area and density a haze will be noticed in the extreme periphery of the lung. This haze when viewed stereoscopically will be seen to occupy the plane of the pleura, while the lung density will be seen in its true plane. In the same individual, by means of serial films, this density was seen to appear in seven months. In another individual it was seen by the same method to disappear to a large extent during a two months' absence from his work. This area seems always to be triangular with its base towards the lung periphery and its apex towards the hilus. It has been felt that this density appearing in the pleural level is a detour of the lymph flow; the path between the periphery and the hilus being blocked, nature seeks to accomplish her end, namely, the removal of the irritant, by making a detour by means of the pleural lymphatics. This pleural haze has been seen extending from apex to various rib levels. An effort has been made to write down the evidence as gathered from a preliminary study of the films. Each one of you will probably correlate it with your own past experience and will probably draw your own conclusions.

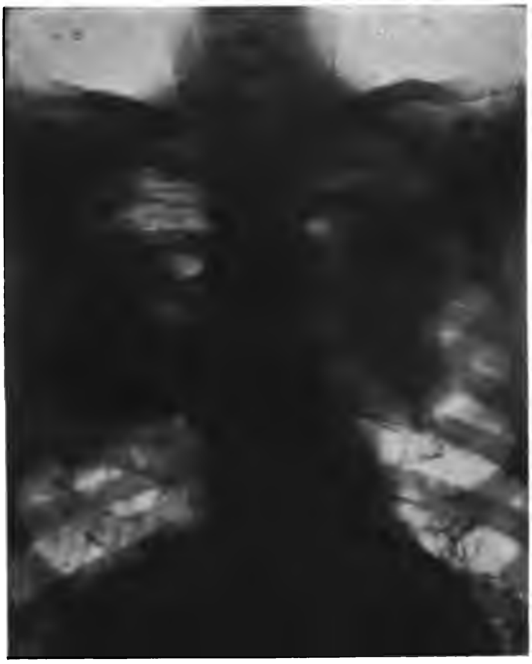

Fig. 17 (96). Exposure twenty-six years. Working constantly. Dullness left apex. Patch of pleurisy below left nipple. Otherwise negative.

SUMMARY

1. Film densities are influenced by mouth breathing, nationality and occupational position.
2. The machinery must be considered as a source of dust as well as the material being worked.
3. A standard exposure technique should be adopted as early as possible in a study of dust inhalation in order that one may feel sure of variations of density.
4. While classification of films is helpful, the lung lesion in a dust worker is like the shifting sand of the sea and each film should be judged by its own individual densities as portraying the pathology in the making in that particular individual.
5. Evidence tends to show that the lesion always remains peripheral and the lung reaction to an irritant is evidenced by densities appearing from the hilus outward.
6. It seems possible to parallel films of tuberculosis, pneumonia and various other pathological conditions of the lungs with the films of granite cutters, there being an absence of clinical activity in the latter, the mechanical irritant producing the same lesion as a bacterial one.
7. It would seem that many densities are being diagnosed as tuberculosis which should be considered as densities of pneumoconiosis.

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THE X-RAY SHADOWS OF LUNG SYPHILIS AND SYPHILITIC-TUBERCULOUS SYMBIOSIS IN THE LUNGS*

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Pathological Laboratory

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WITHIN the past five years, thoracic syphilis has assumed a place of importance in clinical medicine, and our position as leaders in medical research makes it expedient that we give this subject more serious consideration. Attention has heretofore been concentrated upon lesions of the heart and aorta to the unjust exclusion of those which occur in the lung. Up to 1916, the references to pulmonary syphilis in the roentgen literature were remarkable for their scarcity, consisting of case reports from Dachtler,[1] Carman,[2] Pancoast,[3] Dunham,[4] and, possibly, others.

Pathologically, invasion of the lungs by syphilis was recognized by Virchow,[5] Depaul [6] and Pancritius,[7] and described in some detail by Fowler [8] and Stanley.[9] Clinically, many authors have directed their attention to it; some of these, like Osler [10] and McCrae, regard the condition as extremely rare and infrequently recognized, while others consider it to be relatively common. Dieulafoy [11] says "syphilis of the lungs is of the highest importance" and describes six forms, with very discouraging comments on diagnosis. The value of roentgenography for this purpose was brought to the attention of clinicians by the reports from the roentgenologists mentioned, and most writers since have emphasized the fact that the nature of the disease should make it amenable to *x*-ray differentiation. In spite of isolated reports, however, our specialty, as a whole, has taken the position that we can offer little assistance. If this were true, Carrera's [12] statement that the ultimate diagnosis of lung syphilis must wait on the necropsy and microscope would be the correct and hopeless outlook, for clinicians have already exhausted their physical and laboratory methods, and, if we cannot assist them, lung syphilis is likely to remain the *bête noire* of the internist.

However, this challenge presents too fine an opportunity for us to ignore. If we grant that lung syphilis is a clinical entity and comparatively frequent in occurrence; that the pathology in the lungs is characteristic in histologic change and in gross location; then the lesions should certainly be recognized on the radiograph.

This paper presents its material in two parts: I. Lung Syphilis; II. Syphilitic-Tuberculous Double Infection in the Lungs.

PART I. LUNG SYPHILIS

In 1916, we began a systematic search for lung syphilis by including this disease as a possibility in every lung examination, as there seemed to be no mechanical or biological reason for the frequently assumed freedom of the lungs from this infection. Inasmuch as roentgenographic interpretation consists purely of conclusions regarding tissue pathology, drawn from the shadows cast by disease changes, and since the antecedent pathological work on lung syphilis was "fragmentary and vague,"[13] the *x*-ray work necessarily was imperfect. However, several fundamental facts aided in forming a nebulous expectation of the shadows of lung syphilis.

1. The peculiarities in the anatomical structure of the lung, as demonstrated by Miller, with the relations between bronchi, arteries and lymphatics, have an intimate bearing on the interpretation of the shadows of all pulmonary lesions, including lung syphilis.
2. The characteristic method of invasion of active syphilis, wherever found, by ex-

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tension along the arteries, is distinctly different from the extension of tuberculosis through the lymphatics. A consideration of the relations of lymphatics and arteries to the pulmonary subdivisions which are involved, indicated that there would be a distinct difference in the shadows of these two diseases.

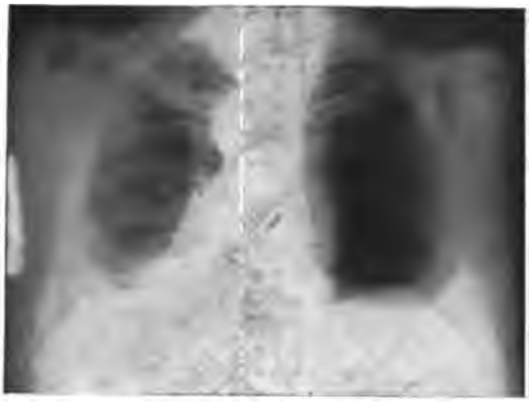

Fig. 1 (Patient 785). Peribronchial fibrotic type of lung syphilis. History of syphilis; Wassermann positive; sputum negative; abatement of lung signs under mercury.

3. Aside from the pathological differences, the clinical observation had been that the lesions of tuberculosis and syphilis occurred, as a rule, in different parts of the lung, the former in the upper and the latter in the lower lobes.

4. The characteristics of the shadow of tuberculosis being already definitely established, the differentiation would be between syphilis and other less common types of lung disease.

Basing our observations on these facts by selecting patients known to have syphilis and making a careful study of the pulmonary densities presented by them, certain types of shadow could, with a fair degree of probability, be classified as syphilitic. Then, by observing the resolution of such shadows after antiluetic treatment, the tentative observations could be confirmed as definitely as we could ever hope to confirm them during the life of the patient.

The handicap of a lack of accurate pathological knowledge was, to a large extent, removed by the publications of Warthin[13] on latent syphilis, in 1918, and the more recent observations of Carrera[12] on the specific lesions in the lung. It should be a matter of satisfaction to those pioneer roentgenologists who interested themselves in this supposedly rare condition, to observe that these belated pathological researches verified the accuracy of their radiographic forecast of tissue changes. The most important result of the pathological work was the furnishing of a basis for accurate classification of radiographic shadows and a definite explanation of some peculiar shadows which had been observed but not, heretofore, interpreted.

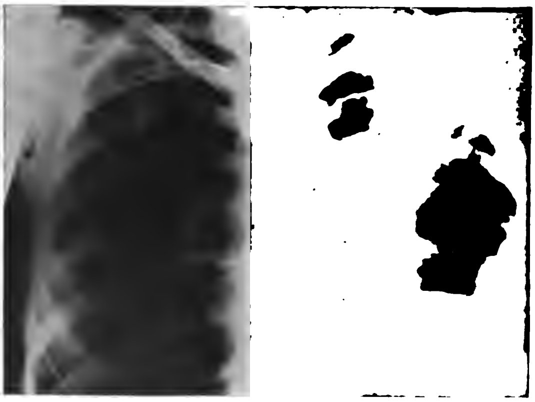

Fig. 2 (Patient 14552). Hereditary syphilitic. Early form of infiltrative type in the left base.

In terms of clinical pathology, we can distinguish three types of radiographic shadow produced by syphilitic invasion of the lung. The classification here differs slightly from that previously offered, in order to conform to recent discoveries.

1. The lesions of active or early syphilis produce shadows which are to be interpreted as (a) gummas, or (b) inflammatory consolidation or infiltration. Such shadows vary according to the virulence of the infection and the rapidity of the invasion.

2. The lesions of old, latent or hereditary syphilis produce shadows which represent (a) interstitial peribronchial or peri-arterial fibrosis, or (b) dense fibrosis of the lung or pleura.

3. In conjunction with thoracic syphilis, indefinite lung densities occur, the nature of which have not yet been determined, either by clinical observation, pathological research or radiographic characteristics. These densities correspond to those seen by Dachtler[1] in his cases reported in 1912.

The wide variation in the shadows of lung syphilis, from a simple peribronchial deposit of fibrous tissue in a limited lung area, to complete consolidation of an entire lung, is explained by Warthin's[13] distinction between the pathology of active syphilis and of latent syphilis.

When active syphilis invades the lung, there is extensive consolidation or inflammatory infiltration, usually in the lower lobe, due to the tendency of this infection to follow the larger arterial trunks. This localization, however, is not absolute, the first case in our records involving the upper left lobe. The shadows of this form of the disease may simulate those of primary carcinoma, or the partially resolved consolidations of pneumonia. The shadows are usually confluent, of varying density, inclined to irregularity and mossiness of the edges, and tend to mass along the heart border and large bronchial trunks. They may be confused with the shadows of bronchiectasis, abscess or pneumoconiosis.

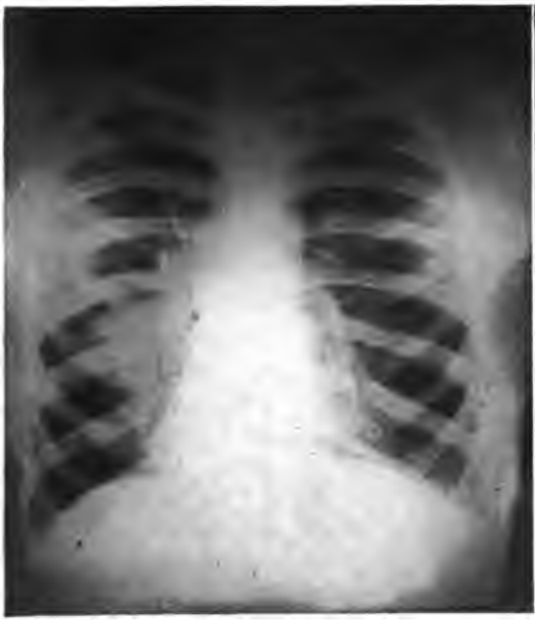
Fig. 3 (Patient 95). Syphilitic infiltration of the upper left lobe.

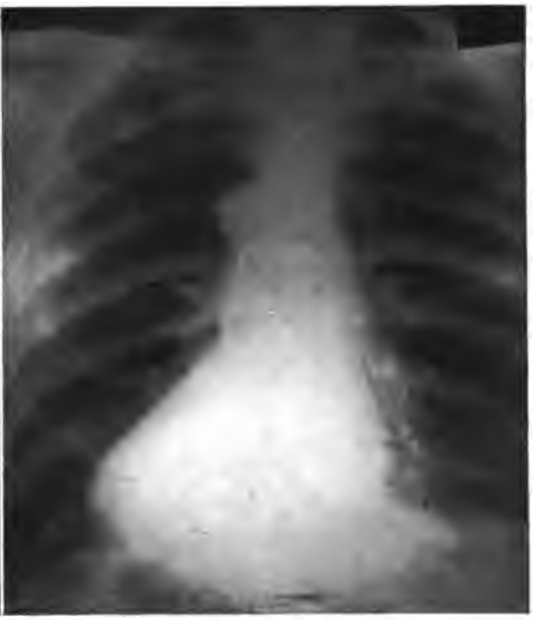
Fig. 4 (Same patient as Fig. 3). Shows change under antileutic treatment.

When tissue resistance is sufficient to encapsulate the diseased area, gummatous lesions result. The shadows of gummas will vary in size; will usually be multiple; are not confluent; will have edges slightly irregular but more definite than consolidations; when caseous, they will have centers of diminished density; when healing, they become irregular in outline, show pointed projections of fibrous tissue which contract the lung and may obstruct bronchi. It is conceivable that gummas may be so thoroughly encapsulated that they will remain smooth in outline and heal without material effect on the surrounding lung tissue.

The interstitial or peribronchial fibrosis, with its end result of dense fibrosis of the lung and pleura, occurs in latent syphilis, where a slow inflammatory reaction, ending in fibrosis, is the typical pathology. This fibrosis may be peribronchial or peri-arterial, but resulting shadows will be the same, consisting of fine or coarse linear striations, springing usually from a dense hilus shadow and radiating to the periphery. The striations may occupy a limited area or involve both lungs generally. Other diseases and irritants, like poison gas, may produce a similar fibrosis.

Indefinite lung densities are frequently found in association with cardiac or aortic syphilis. Both Warthin and Carrera described lung changes which correspond to such densities, but were undecided whether they represented inflammatory reactions or passive congestion from mechanical conditions. While we wait on the pathological determination of this point, we wish to record our conviction that, radiographically, these densities are specific inflammatory reactions, and have been seen to disappear under antiluetic treatment. This has been observed both when they were found in connection with aortic disease and when they occurred in lungs without visible cardiac or aortic involvement. There are, of course, radiographic densities which are the result of passive congestion or pulmonary edema from cardiac embarrassment in syphilitic valve disease, but there should be no difficulty in differentiating these.

Since radiographic visualization of tissue change is only one of the many physical methods of investigating disease it would, manifestly, be improper and even impertinent to venture unqualified diagnoses of lung syphilis from radiographs alone. We need to take into consideration the personal history, the clinical evidences of systemic disease, the possible accompanying involvement of the heart or aorta, the other physical signs of lung disease, and the laboratory findings. However, the roentgenologist, as a consultant, has just as much right to consider all these evidences in connection with his special investigations, and produce the completed result as a diagnosis, as the clinician has to appropriate the radiographic interpretation and use it to connect his otherwise incomplete chain of evidence. In other words, we need to follow the teaching of a former distinguished President of this Society[14] and conduct ourselves as consulting diagnosticians.

Up to August 1, 1920, we have on record approximately 6500 examinations of the chest and heart. In this number we have made, or assisted clinicians in making, diagnoses of pulmonary syphilis in 172 patients; that is, of patients radiographed for suspected heart or lung disease, about 2.6 per cent had pulmonary shadows which we could reasonably conclude were due to uncomplicated syphilis. Many of these lesions were in combination with cardiac or aortic syphilis; in others there was no visible heart involvement. It will not be the function of this paper to enter further into statistical report or classification of these cases.

Part II. Symbiotic Infection

The characteristics of the tuberculous shadow are well known, and there is need to review them only so far as necessary to establish a basis of comparison with those of syphilis. Many illustrations, such as the goldenrod, the dandelion and the sunflower, have been suggested to fix the picture of the shadow of tuberculosis in our minds. The incongruity of illustrating disease pathology by means of a flower impels me to suggest a more appropriate simile. A thickly leaved tree, like our Western cottonwood, with a caterpillar web enmeshing numerous leaves and small twigs, sometimes large branches, graphically illustrates the tuberculous lesion; the shadow of this on a concrete pavement, with the sun at medium height, is an excellent representation of the radiographic reproduction. The leaves are the secondary lobules of Miller, the twigs and branches being the bronchi and accompanying vessels. Now, if we can fancy some destructive influence which blocks the circulatory system of these branches, so that the leaves wither and die, without web formation, we shall have an illustration of syphilis of the lungs, and the differences in their fundamental pathology.

As a general rule, tuberculosis, uncomplicated by mixed infection, will invade the upper lobes of the lung, and its shadows will be found over the peripheral distribution of some of the upper lobe bronchi. The bronchial twig or branch involved may be small and the shadow correspondingly limited, or the area involved may be large, even an entire lobe; but the shadow will be a peripheral shadow and will be in the upper lobe, whether the tuberculosis is of the minimal degree, barely perceptible on the radiograph, or whether it is of the most extensive degree, involving all branches of both upper lobes. When tuberculosis spreads from the upper lobes into the lower areas, or when it invades the central or basal regions primarily, we may expect to find an accompanying or antecedent mixed infection, producing an atypical localization of the tuberculous lesions. There may be exceptions to this rule, but it forms the clinical basis of our interpretation of tuberculous shadows, and many observations have only strengthened our conviction that this is a safe working basis, in spite of exceptions which we have observed and which others, no doubt, can cite.

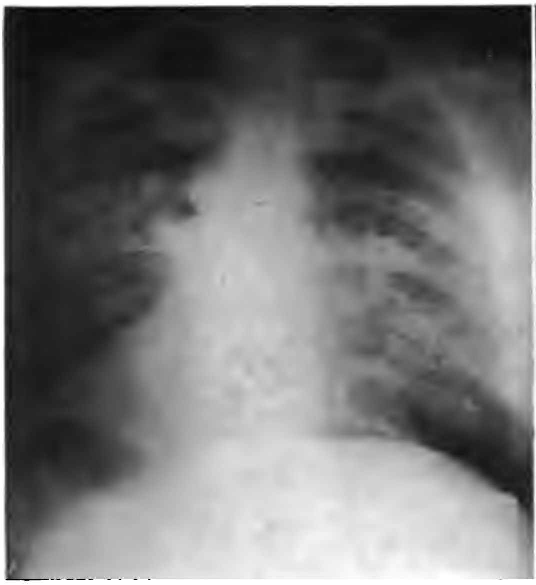

Fig. 5 (Patient 3134). Extensive syphilitic infiltration of right base. Almost entirely resolved following two injections of salvarsan.

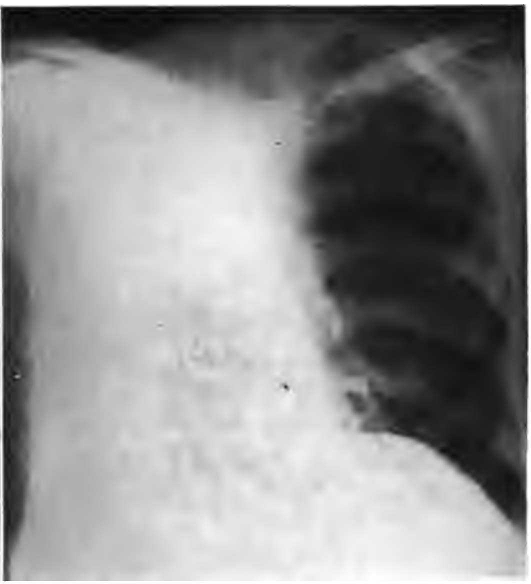

Fig. 6 (Patient 8675). Syphilitic sclerosis of lung and pleura. Wassermann positive. Autopsy showed complete destruction of lung tissue, with cicatrication, and large annular aneurysm of aortic arch.

The interrelation between tuberculosis and syphilis has been in the minds of clinicians since tuberculosis was isolated from other lung diseases and established as a clinical entity. The effects of the acquirement of tuberculosis by a syphilitic person, and vice versa, have been discussed at length by many writers, but without definite conclusions, due, no doubt, to the uncertainty regarding syphilitic infection in the lung. Until there was a clear conception of lung syphilis itself, naturally no very definite idea regarding its combination with tuberculosis could be formed. Certain clinical observations which have served only to befog an already very puzzling condition are all that we have to date regarding a sinister combination which affects from 15 to 20 per cent of our great army of tuberculous patients. We have the conflicting statements that syphilis acquired by a tuberculous person will exert a favorable effect on the course of the tuberculosis; and, conversely, that it will cause a rapid extension of the tuberculosis. We also have the confusing statements that a syphilitic who acquires tuberculosis will usually have an acute disease; and, conversely, that tuberculosis acquired by an old syphilitic behaves no differently from tuberculosis in a previously healthy person.

It is very apparent that here is a rich field for study. It is safe to assume that the previous observations on this double infection are not a safe guide, being necessarily based on an insufficient knowledge of the pathology of lung syphilis, and we can far better found our conclusions on our own investigations. Any such conclusions regarding a combination of syphilis and tuberculosis in the lung must give full consideration to the differences between an active, syphilitic inflammation, and the mild, slow fibrosis of old or latent syphilis.

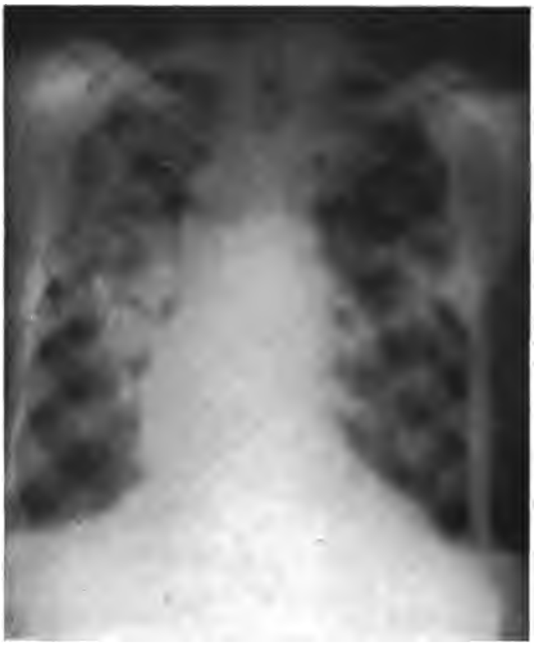

Fig. 7 (Patient 11495). Diffuse and irregular densities in lungs accompanying syphilis of heart and aorta, probably due to active lung disease.

Tuberculosis and syphilis may occur simultaneously in the same lung, each producing its own lesions, which frequently can be distinguished on the radiograph. Since each of these shadows have been described, it is not necessary to dwell further on them.

The two diseases may also occur as a true symbiosis. This peculiar condition was first brought to the writer's attention by the publication of the researches of Dr. Carl Spengler,[15] of Davos, in whose papers we found an adequate explanation for the brilliant therapeutic results of Wright in treating tuberculosis with injections of mercury salts. The term symbiosis carries with it a tacit denial of the supposed antagonism between the organisms of tuberculosis and syphilis, for which there is no biological or clinical evidence. Symbiosis occurs when syphilis prepares the soil, either by active inflammatory destruction of lung tissue, or by a slow, mild inflammatory congestion. The localization of tubercle bacilli, thus influenced by syphilis, is more widespread, and we find the lesions and shadows not only in the upper lobes, but also in the bases. A symbiosis is also represented by the effects of acquired syphilis on a latent tuberculosis. Here, as Dieulafoy expresses it, the syphilitic virus "hatches the tubercle bacilli and sows them broadcast." A widespread distribution of tuberculosis may be produced by the latent, as well as the active form of syphilis. However, active syphilis, when grafted upon a preceding tuberculosis, results in a very malignant disease, which may not be true when tuberculosis is implanted in a lung where latent syphilis already exists. It is conceivable that a well established fibrotic tendency produced by a long-standing latent syphilis of the lungs, will choke out a tuberculous process when the latter occurs as a secondary infection. This, however, is tissue resistance and not bacterial antagonism, a distinction which is of vital importance in treatment.

A very similar symbiosis is found when tuberculosis and streptococcic infection exist in the same lung. A generalization of the tuberculosis results, because tubercle bacilli develop with greatly enhanced rapidity and vigor on a soil where streptococci have already grown. This fact, first demonstrated in the laboratory, has not been given proper consideration in studying the effects of "influenza" on tuberculosis. When we deny that influenza has any effect on tuberculosis we are making a categorical statement that tuberculosis is not affected by any of the virulent pyogenic organisms which infest the respiratory tract, since these are all concerned, either primarily or secondarily, in influenzal infections. Now we do know that streptococci affect tuberculosis very markedly, and it is entirely possible that the cases studied by Fishberg[16] were pneumococcic infections, while those studied by other observers, with contrary conclusions, were streptococcic infections. However that may be, the streptococcic-tuberculous mixed infection will produce shadows very atypical for tuberculosis, and which cannot be distinguished, radiographically, from the shadows of tuberculous-syphilitic mixed infection. When we find typical shadows of tuberculosis and other shadows, usually of more recent formation, in atypical locations and without the familiar characteristics of tuberculosis, we may conclude that some additional and more malign agent than tuberculosis is at work in that lung. We cannot here, any more than we can in pure lung syphilis, draw positive conclusions from the shadows alone. However, these frequently are quite suggestive, and if our radiographic examination gives the right clue and leads to the ultimate formulation of a correct diagnosis, it certainly has done all that can reasonably be expected.

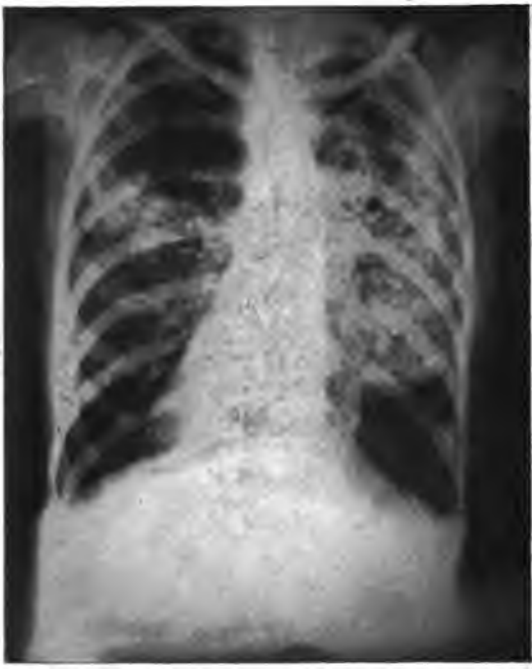

Fig. 8 (Patient 8133). Generalization of tuberculosis by streptococcic infection of the lungs.

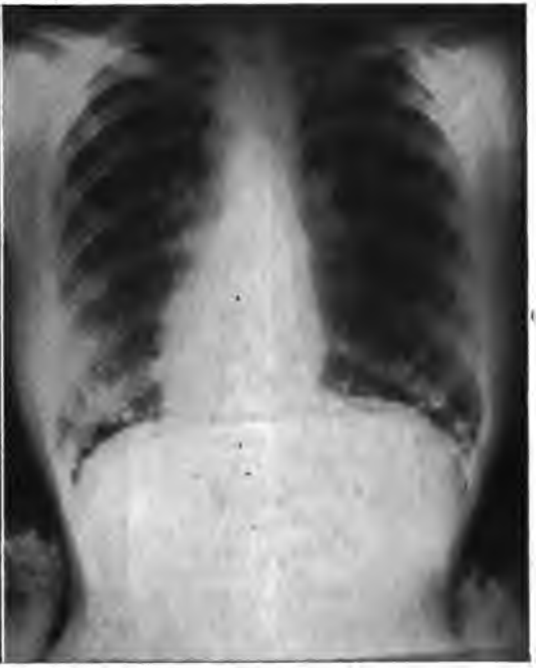

Fig. 9 (Patient 8825). Healed tuberculosis of the lungs and pleura. Stereoscopically lesions shown to be partly in the lungs and partly on the pleura. History of pneumonia, with slow recovery extending over two years.

When we find pulmonary tuberculosis, with cavities which fill up with streptococcus infected pus, and, beneath these, the shadows of a disseminated tuberculosis, the conclusion should be obvious.

When the tuberculous process is under the influence of a symbiotic syphilis, the characteristics of neither infection will be preserved. Dieulafoy cites a case of a caseous gumma whose outer rind was thickly studded with tuberculomas about the size of peas; the shadow of such a lesion naturally would be very atypical. We may find areas where the typical tuberculous shadows are preserved; elsewhere there will be groups of small, rounded, or irregular densities, representing small consolidations without detectable relation to bronchial stems. Where the syphilitic areas have been invaded by tuberculosis, or where the encapsulated tubercle is broken down and the bacilli disseminated by the effects of syphilis, we cannot expect to find any typical arrangement of shadow. The absence of infected cavities, the confluence of small consolidations along the heart border, large hilus masses, diffuse fibrosis, should suggest syphilitic rather than pyogenic double infection.

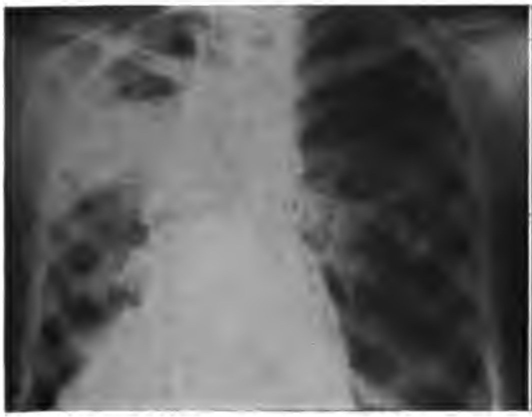

Fig. 10 (Patient 8325). Tuberculosis and syphilis, shadows in the left lung resembling carcinoma, but proven by course of disease and effect of treatment to be syphilitic.

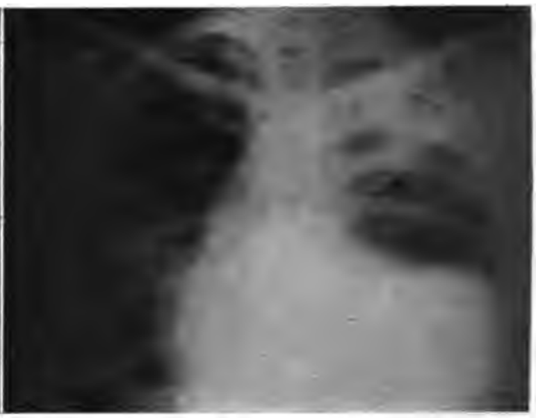

Fig. 11 (Patient 4668). Tuberculosis of upper right, with effusion in the base. Gummatous lesion of syphilis near left heart border. Entirely resolved under anti-luetic treatment, while the right sided lesions spread rapidly.

In the 6500 examinations previously mentioned, there were 948 patients who showed lesions of tuberculosis which had reached the advanced degree according to the classification of the National Tuberculosis Association. There were 192 cases whose radiographs had been disposed of and whose records were not clear enough to permit definite classification. In eleven patients there was acute tuberculosis, without radiographic evidence of a source of mixed infection to explain the generalization, and without history of antecedent acute respiratory disease. In 195 cases, the basal regions were practically free from abnormal shadow, the lesions being confined to the upper lobes, and these were considered to be essentially uncomplicated tuberculosis. In 550 patients the lesions had become disseminated into the lower lobes, and shadows were present which were atypical for tuberculosis and which could be explained only by some form of mixed infection. In 209, or over 22 per cent of the 948 patients with advanced tuberculosis, a diagnosis of combined syphilis and tuberculosis was made by us, or with our assistance. In the remaining 341 patients, a

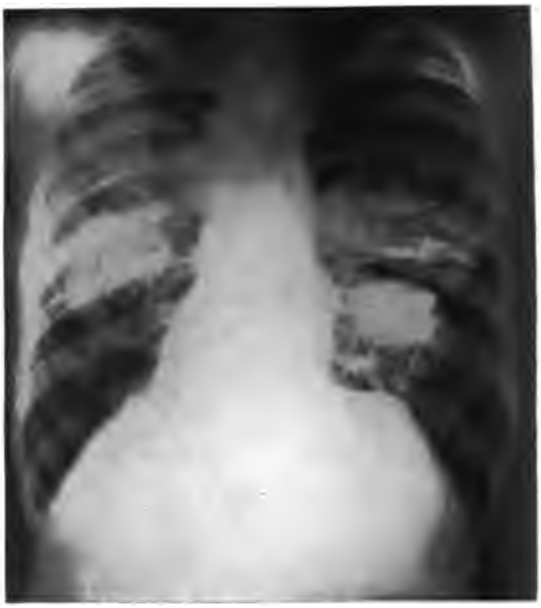

Fig. 12 (Patient 9553). Combined tuberculosis and syphilis of the lungs, with aneurysm of the aortic arch.

simple diagnosis of tuberculosis plus some form of undetermined mixed infection was the conclusion from the radiographic shadows. This report includes only patients showing extensive shadows, and we have, doubtless, failed to recognize the true conditions in many patients with less advanced disease.

In closing this inadequate presentation of a very timely subject, it is well to emphasize its importance from a therapeutic standpoint.

First: In the treatment of systemic lues, it is important to know whether the lungs are involved, since a Herxheimer reaction in the lungs may be serious.

Second: It is doubly important, in tuberculosis, to ascertain whether the patient combats this comparatively benign single infection, or whether a sinister combination with active syphilis must be treated.

Third: It may be triply important not to disturb the fibrotic changes of latent syphilis by arsenical treatment, if the tendency of this fibrosis is to arrest the tuberculosis.

In all events, roentgenological examinations are indispensable, and the opportunities for scientific research and for practical benefit to medicine and humanity afforded us in the symbiotic infection, are not exceeded by any other lung disease.

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DISCUSSION

MR. H. W. DACHTLER. This paper has been of considerable interest to me, as the work I did some years ago was on the secondary manifestations of syphilis, and of course my findings were entirely different. We found at that time, that the roentgen examination was practically negative. In other words, these cases had physical signs of an early tuberculosis, including slight temperature, but no roentgen signs that would verify that, and our conclusions were that it was a diffuse bronchitis in the secondary stage of syphilis, and where we found such cases with negative roentgen findings, we suspected lues. I have had, during my experience, three cases that are somewhat similar to some of the cases shown by the doctor, where there were discrete nodules. All of these cases had a history of syphilis, but we were never able to verify them by postmortem examination.

I find it difficult to make clear that the findings we observed were not those of gumma. I have no cases in all my experience which I can identify as true syphilis of the lung. Those cases of secondary syphilis had antisyphilitic treatment, and they never developed any fibrosis, and for a very good reason—because the cases were early and they were cured, and the condition did not develop further.

DR. KENNON DUNHAM. I know of nothing that is more important than the study of syphilis of the lung. We are getting, thanks to the *x*-ray man, more evidence every day which may some day help to substantiate a diagnosis of syphilis. I suppose there is not a large laboratory in the country that has not had definite lesions showing atypical densities which have cleared up under salvarsan. We have such plates in Cincinnati and we often treat them with salvarsan, but I hope, as roentgenologists, we shall not go on record as making a diagnosis of syphilis of the lung from these abnormal conditions. We can say that "such and such" a density suggests syphilis, but we cannot diagnose syphilis. The fact that a patient has a four-plus Wassermann does not mean that a given lung density is due to syphilis.

The specific organism of syphilis has not been demonstrated in the lung. Pathologists recognize two forms of pulmonary syphilis—

white pneumonia of the new born child, and gumma. Mr. Dachtler showed years ago that many cases which have physical signs of pulmonary tuberculosis but which have no roentgen findings of tuberculosis must be syphilitic, because they do not react to tuberculin and are cured by anti-syphilitic medication. Do not forget this important research of Mr. Dachtler. Even if we prove that certain abnormal densities within the lung are due to syphilis Dachtler has already proven that we may have pulmonary symptoms due to syphilis which do not give such abnormal changes.

Dr. Pritchard of Battle Creek, some time ago, showed me a series of slides in which lung densities had cleared up under salvarsan. I had similar plates in my own laboratory, and as I said before they are common in almost every large roentgen laboratory.

Let us remember that all these evidences of syphilis of the lung are not proof. Until the specific organism can be demonstrated in at least one such tumor we are not justified in doing more than suggesting pulmonary syphilis from our plates.

Dr. George W. Holmes. I have listened with a good deal of interest to Dr. Watkins' paper. We have had a few cases of lung syphilis which have been fairly well studied. The most interesting finding is a lesion in the bronchi causing a stenosis, and in some cases a complete collapse of the lung, producing complete dullness over the affected area The milder forms clear up under salvarsan when the bronchial stenosis is relieved. One advanced case came to autopsy. We could get no report from the pathologist except that "the patient may have had syphilis." We could not get him to say definitely that it was syphilis.

Dr. P. M. Hickey. I would like to ask the Doctor if he has any observations on syphilis of the pleura. I remember one case where I diagnosed tuberculosis with pleuritis, with a constant recurrent effusion, and the condition cleared up very quickly under salvarsan treatment.

Dr. W. W. Watkins (closing). I don't think I have anything particular to add, except to call attention to the fact that Mr. Dachtler stated in his cases there were no roentgen findings. In his original article, he mentioned in practically all of the cases that the bronchial markings were increased. This may or may not be similar to early syphilis changes.

I agree with Dr. Dunham thoroughly in the inadvisability of making the diagnoses from roentgenograms alone. My idea is to suggest syphilis as one of the things which produces the shadows which we see; never to make a positive diagnosis until the shadows have disappeared and the patient is well.

Answering Dr. Hickey's question, I have observed syphilis of the pleura in two cases, one where involvement of the pleura obscured the entire thorax on one side, where the probable diagnosis of syphilis was confirmed shortly after by autopsy. The other was a syphilitic pneumonia involving the pleura, in which the patient apparently recovered from the pneumonia, but the pleura always remained thickened.

ANEURYSM OF THE AORTA AND ABSCESS OF THE TRACHEOBRONCHIAL LYMPH GLANDS

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CASE 280177, Mrs. W. S., aged twenty-nine, wife of a farmer, was admitted to the Clinic July 15, 1919. Her health had been good until three months before admission. With the exception of abscessed teeth, several of which had been extracted about six weeks before, she had been in good health. The onset of her illness was gradual with a general tired feeling and some pain in the right side of the chest and around the heart. Her symptoms were attributed to overwork, but rest and later one week in a hospital failed to improve her condition. Within two weeks of the extraction of her teeth her temperature rose in the evening, reaching an average of 99 degrees; her pulse was rapid, and her breath short on exertion or when she was lying on her back. She choked at times when taking food. Half an hour after eating she had coughing spells in which she raised large amounts of clear sputum. Later a wheezing in the throat of gradually increasing severity was noted. She lost seven or eight pounds in weight during her illness.

Examination revealed slight bubbling râles over the chest. The heart was not enlarged; a systolic murmur was heard only at intervals; the pulse was rapid and irregular. The abdomen and pelvis were negative. The systolic blood pressure was 120, the diastolic was 80, the pulse was 100, and the temperature 99.5°. Examination of the blood was not recorded. The Wassermann reaction was negative.

Roentgen examination revealed a mass bulging into the upper mediastinum which with the fluoroscope proved to be non-expansile but was thought to be an aneurysm of the arch of the aorta.

The patient died four days after admission to the Clinic; the necropsy findings were as follows:

A large spherical, encapsulated, non-tuberculous abscess of the tracheobronchial lymph nodes (from 10 cm. to 12 cm. in diameter) was found. This mass, situated at the bifurcation of the bronchi, rested behind the bronchi, more to the left side, in front of the esophagus, and against the right pulmonary artery and vein and the descending arch of the aorta. There was evidence of extensive compression of the trachea and of the esophagus. The bronchial tree was filled with unexpectorated mucus and the entire venous circuit was markedly engorged. The body was strikingly livid and showed moderate emaciation with some edema.

CASE 8734. Mr. G. R., aged fifty, a bartender for a time and later a stationary engineer, was admitted to the Clinic August 28, 1919, complaining of a dull pain in the left chest. This pain was not influenced by respiration, but was accentuated by coughing or sneezing. He had had left side pleurisy with effusion five years before and five attacks of pleurisy in the intervening period. He had left side pneumonia in 1918 and in 1919 was confined to bed for several days with "chest trouble." At this time he had a tickling sensation extending down the left bronchus, followed by a slight cough and a small amount of whitish expectoration. In 1908 the patient had been treated at the Clinic for urethral stricture; he had had chancre at the age of twenty-seven and a history of gonorrheal infection over ten years. He complained of shortness of breath, weakness, aching between the shoulders at night, occasional night sweats, and that he was incapacitated for work. He had lost twenty pounds in weight in six months.

Examination revealed general adenopathy, expansion was limited on the left side of the chest; the percussion note was flat; vocal resonance and vocal fremitus were diminished. The breath sounds on the left side were distant; there were no râles, and no changeable dullness. The pulse was regular; a systolic murmur heard at the base and to the left of the mid-sternal line was believed to be an accentuated second sound. The systolic blood pressure was 136, the diastolic 92; the hemoglobin and blood count were normal. Examination of the sputum, the Wassermann reaction, and the electrocardiographic findings were negative.

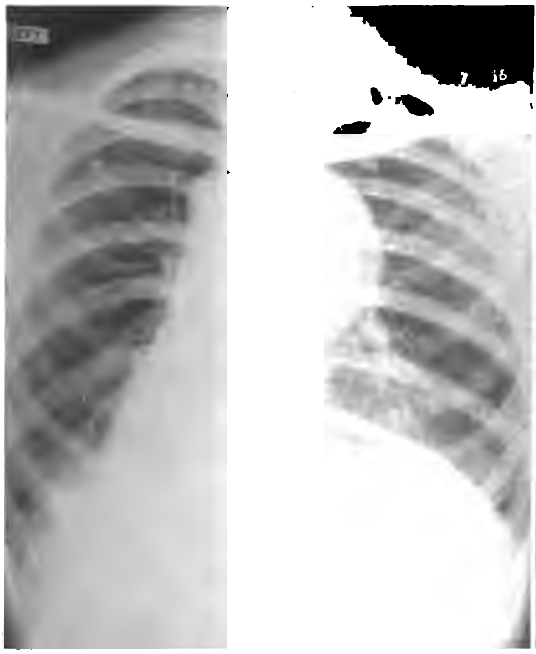

Fig. 1. Case 280,177. Shows shadow bulging into upper mediastinum.

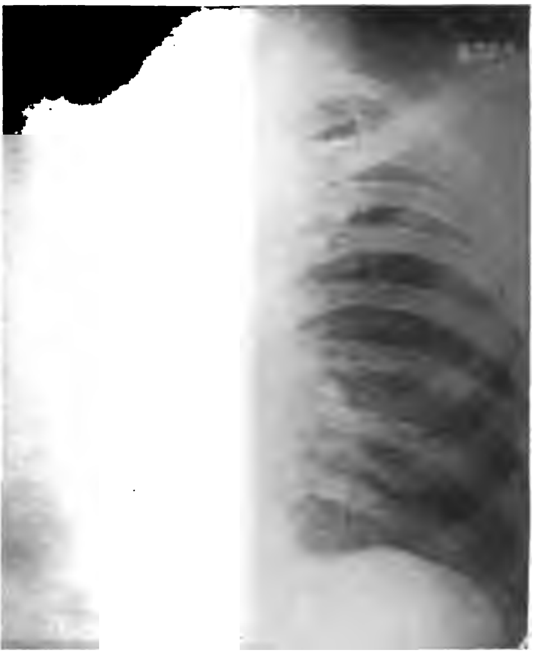

Fig 2. Case 8734. Shows dense shadow in area of left lung.

Roentgen examination revealed a dense shadow throughout the entire area of the left lung. This suggested fluid, but aspiration failed to reveal it. An attempt to elicit fluid two days later by the same method failed and a small incision was made, deep enough to allow a few tiny bubbles of air to escape. The pleura was not appreciably thickened but appeared to be adherent to the lung. Pneumothorax did not follow these operative procedures.

The patient returned to his home September 2, and word was received of his death in November.

We are indebted for the following notes to Dr. T. R. Martin, of the Duluth Clinic, who performed the necropsy:

"On opening the chest both pleural cavities were found to be obliterated by old adhesions and the pericardium was adherent to the pleura on the left side. The lungs and heart were removed *en masse;* in stripping down the descending aorta the knife met with an obstruction, which proved to be an aneurysm of the first portion of the descending aorta, about 9 cm. by 10 cm., containing an organized clot. The posterior wall of the aneurysm was firmly adherent to the spine and had produced pressure necrosis on the lateral aspect of three of the dorsal vertebrae.

"There were no abnormalities of the heart or pericardium except calcareous deposits at the bases of the cusps. The aorta showed numerous calcareous plaques at the site of the aneurysm. On introducing the finger through the auricle into the pulmonary vein an obstruction was met which suggested an acute angulation of the vein from pressure and distortion by the adherent aneurysm. The pulmonary artery on the left side was patent.

"The left lung was dark red, glistening, and moist; on section it was firm and liver-like in consistency and contained no air.

"There was nowhere any evidence of tumor formation.

"A roentgenogram was made of the heart and left lung removed from the body and in this the left lung cast a shadow more dense than the heart free from blood suggesting that the antemortem shadow in the left lung was due to passive congestion."

In Case 280177 the plates and fluoroscopic examination revealed a non-pulsating shadow bulging into the upper mediastinum, which could not be distinguished from the arch of the aorta (Fig. 1). In spite of the patient's age, a negative Wassermann reaction, and the fact that the shadow was non-expansile, aneurysm, in our opinion, was the logical diagnosis. In the literature it is generally agreed that aneurysm rarely occurs without a coexistent history of syphilis; on the other hand, it is known that patients may acquire syphilis unknowingly and that the Wassermann reaction may be negative in the presence of syphilitic infection. No expansile pulsation was observed in the shadow in this case, but it is not always present in aneurysm of the arch of the aorta.

In Case 8734 the roentgen findings were definitely those of fluid in the pleural cavity (Fig. 2). The course of the aorta could not be defined because of the extent and density of the shadow. The clinical findings were as characteristic of fluid as were the roentgen findings and the history of repeated attacks of pleurisy and a left side pneumonia was definitely misleading.

In corresponding with Dr. E. L. Tuohy of the Duluth Clinic we learned that because of the patient's history of syphilis he had earlier in the summer been given rather intensive treatment for syphilis without any apparent improvement in his condition.

A noteworthy feature of these two cases was that the Wassermann reaction was negative in both, although in the second there was a definite history of syphilitic infection.

These two cases are of interest because the roentgen findings were considered characteristic enough to allow of a definite diagnosis, yet necropsies proved them to be incorrect.

PELVIMETRY BY MEANS OF THE ROENTGEN RAY[*]

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AND
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By the use of films and double screens, it has recently become possible to get clear pictures of the maternal pelvis and the fetal skeleton at full term. This seemed to us to reopen the question of roentgenographic pelvimetry.

Martius[1] has given a very complete review of the literature on the subject up to 1914. After the first simple comparisons of roentgenograms of the patient with those of dried abnormal pelves, various mechanical and mathematical methods were developed to correct for parallax and foreshortening. The mechanical method culminated in the very complicated and expensive chair designed by Kehrer and Dessauer[2], which reconstructed by threads in space the straight lines connecting target, object and plate image and measured between their intersections. Martius found their method accurate enough, but they themselves were unable to get plates clear enough to measure after the first few months of pregnancy. The mathematical method culminated with that of Runge and Gruenhagen[3] in 1915, which is both simple and accurate. The only special apparatus used is a plate tunnel and a plumb-bob. They availed themselves of the stereoscope to identify the points from which to measure on the plate, a refinement first used by Manges[4] in 1912. It is a simplification of this method that we are offering.

In using films, it seemed desirable not to use the edges to orient them by, as Runge and Gruenhagen had done with plates, so we have had a plumb-bob impress its shadow on each exposure. We have discovered a simple construction for the horizontal projection of the desired diameter, which is even easier than the perpendicular from which Runge and Gruenhagen measured, and in addition simplifies the final calculation.

THE APPARATUS

We are using a tube-stand and table of standard make, the double screen cassettes being carried on the plate changer provided in the table. Across the celluloid window, somewhat above the middle, is stretched a wire (about 20 gauge). In the center of the 1 mm. aluminum filter is a very small lead ring, from which hangs on a cotton string a plumb-bob, consisting of a rod 3 by 50 mm., with two rods 1 by 30 mm. set through it near the end at right angles to its long axis and to each other.

METHOD OF TAKING THE PICTURES

The target is set 88 cm. above the plane of the film. We have chosen this target distance arbitrarily. The shadow of the plumb-bob is observed on a bare screen, and the tube holder is tilted until the shadows of plumb-bob and lead ring are concentric, thus bringing the plumb-bob vertically below the target. The patient is made to lie down on the table, with her pelvis over the celluloid window, a lead marker is placed under her right hip, the tube is brought over the right iliac region and an exposure made. The tube is shifted 10 cm. to the left parallel to the wire above mentioned, and another film exposed. It is necessary that the exposures be full, for an under exposure will fail to show the shadow of the plumb-bob, and the promontory of the sacrum will probably be obscured by the density of the fetal head. With a radiator

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[*] Read at the Winter Meeting of the Pacific Coast Roentgen Ray Society, and the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY, San Francisco, California, December 10, 1920.

Coolidge tube about 15 sec. at 30 ma. at a 4 inch gap has given readable pictures.

MEASURING THE FILMS

The films when dry are placed in the stereoscope, or are viewed on the light box with a prism hand stereoscope, and the points marked between which measurement is desired, e. g., the promontory and symphysis, the ischial spines, the brim at sacroiliac joint and ileopectineal eminence, etc. Then on the light box a piece of clear celluloid is laid over one of the films, and on it marked (1) two dashes over the shadow of the wire, (2) the center of the plumb-bob, and (3) the points on the pelvis, labeling each pair. The celluloid is then laid over the other film, setting the dashes over the shadow of the wire, and the mark for the plumb-bob exactly 10 cm. from the second plumb-bob shadow. The points on the pelvis are then marked in their new positions. Draw lines connecting the plumb-bob dots with the pelvis dots belonging to each, and another connecting the intersections. The tracing for measuring, say, the conjugata vera, will then appear thus (see Fig. 1).

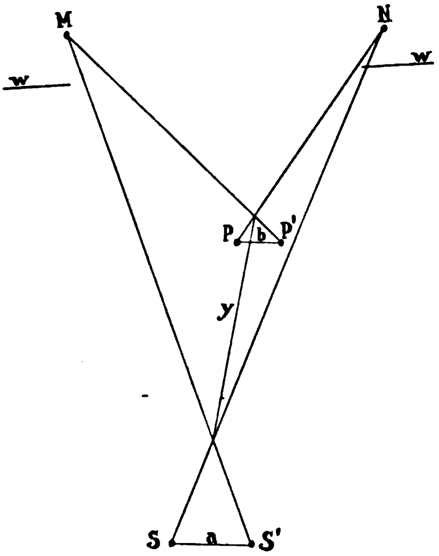

Fig. 1. Tracing ready for measurement. M and N are the plumb-bob marks. *w* and *w* mark the wire, P and P′ the promontory, and S and S′ the symphysis.

A centimeter scale laid on y gives the length in centimeters of the horizontal projection of the required diameter. A special scale laid on a and b gives the height in centimeters of each end of the conjugate above the plane of the film. The length of the conjugate is then computed from the formula:

$$x = \sqrt{y^2 + (a-b)^2}$$

ACCURACY

As a check on the method we have used a light wire 10 cm. long with spherical knobs on the ends. This is laid across the symphysis when the exposures are made. If calculation from the films gives the length of this correctly, then one may be sure that no mistakes were made, and can trust the calculations for the other measurements. Accuracy in determination of the pelvic diameters will depend almost entirely on the accuracy with which the points are marked on the films. That this is a real cause of error was shown by determinations on dried pelves, where the results at times differed from the calipered lengths of the antero-posterior diameters by as much as 4 mm. This I believe was due to the difficulty of marking accurately the posterior surface of the symphysis. The promontory of the sacrum is also, to a less degree, a source of uncertainty. The oblique diameters of the inlet and that between the ischial spines are, however, always very definite, and these are not only of prime importance in the mechanism of labor but are most unsatisfactorily estimated by the classical methods of pelvimetry. Error here has been less than 2 mm.

It should be pointed out that the method we have described is more widely useful than merely for pelvimetry. It can be used for measuring almost any of the dimensions of the skeleton, and perhaps even of soft parts. By taking a third exposure to rule out movement, the dimensions of the fetus may be estimated.

We wish to thank Dr. A. B. Spalding for the interest he has taken in this problem and for the use of clinical material from the obstetrical service of Lane Hospital.

For completeness the mathematical treatment of the problem is given below, but an understanding of it is not necessary in the actual use of the method.

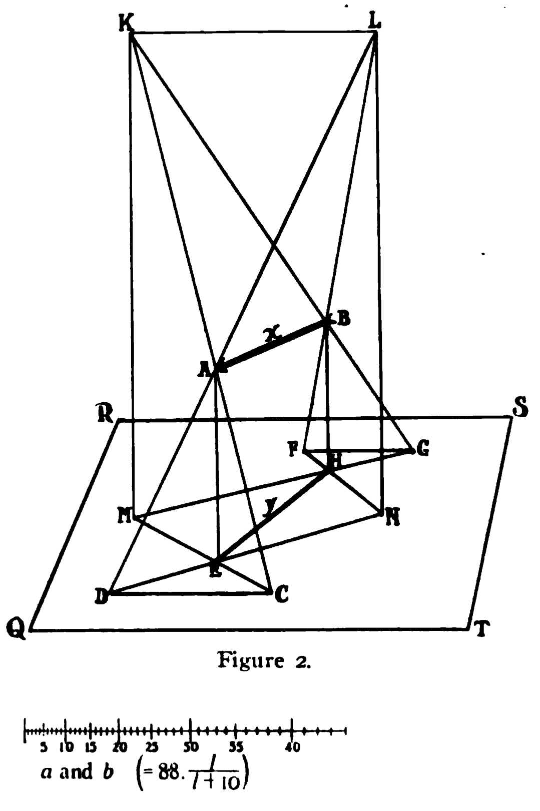

Figure 2.

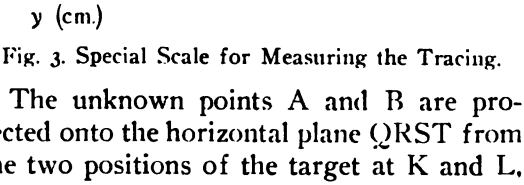

Fig. 3. Special Scale for Measuring the Tracing.

The unknown points A and B are projected onto the horizontal plane QRST from the two positions of the target at K and L, showing as the points D. C. F and G. M and N are the plumb-bob shadows and lie vertically below K and L respectively. (Fig. 2.)

Since in the triangles KMC and LND, KM and LN are vertical, MC lies vertically under KC, and ND under LD. Therefore E, the intersection of MC and ND, is vertically under A, the intersection of KC and LD; i.e., AE is vertical.

Similarly BH is vertical.

Since HE is horizontal, the figure ABHE is a right trapezoid. Its hypothenuse, AB, is the length to be measured.

$$\therefore (AB)^2 = (EH)^2 + (AE - BH)^2$$

EH is y in Figure 1 and directly measurable; and AB is the unknown length x.

$$\therefore x^2 = y^2 + (AE - BH)^2$$

$$x = \sqrt{y^2 + (AE - BH)^2}$$

Since KL is parallel to QRST, KL, DC and FG are all parallel.

$$\therefore \frac{KL}{DC} = \frac{KA}{AC}$$

$$\frac{KL + DC}{DC} = \frac{KA + AC}{AC} = \frac{KC}{AC}$$

$$\text{But } \frac{KC}{AC} = \frac{KM}{AE}$$

$$\therefore \frac{KM}{AE} = \frac{KL + DC}{DC}$$

$$AE = KM. \frac{DC}{KL + DC}$$

$$\text{Similarly } BH = LN. \frac{FG}{KL + FG}$$

We have chosen KM and LN = 88 cm. and KL = 10 cm.

$$\therefore AE = 88. \frac{DC}{DC + 10}$$

$$\text{and } BH = 88. \frac{FG}{FG + 10}$$

If, now, we construct a scale on which a length of 1 cm. reads $88. \frac{1}{1 + 10}$, we can by applying it to DC and FG, read off directly the magnitudes of AE and BH respectively. Let us call these readings a and b, then the formula becomes:

$$x = \sqrt{y^2 + (a - b)^2}$$

For convenience we have printed on a piece of celluloid a centimeter scale for reading y as well as the special scale for reading a and b. (See Fig. 3.)

SUMMARY

A simple method is described for measuring bony dimensions, notably of the female pelvis, by means of roentgen rays. The special apparatus required comprises: 1. a cross-arm plumb-bob. 2. An aluminum filter with small lead ring from which to hang the bob. 3. A light bar of known length for an automatic check on the accuracy of the exposure-making. 4. A special scale to lessen the burden of the calculations. (See Fig. 5.)

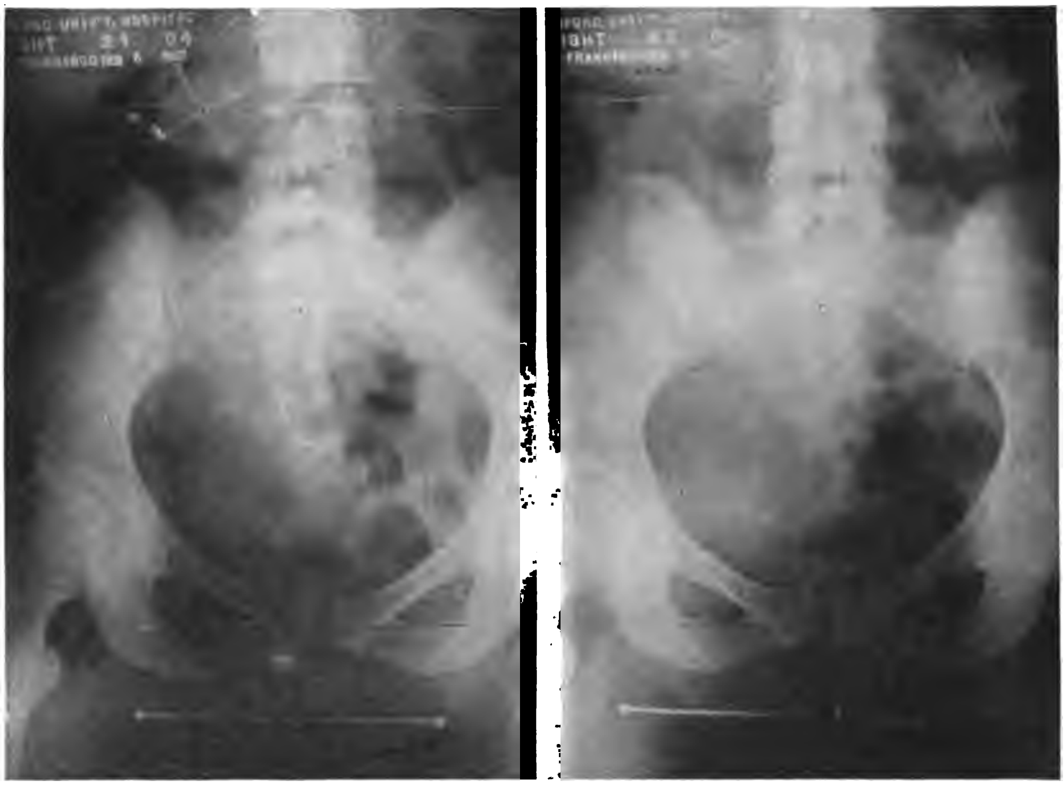

FIG. 4. The two films marked and ready for tracing. Dots have been put at the ends of all the principal pelvic diameters (internal). The line drawn between the ischial tuberosities is for the measurement of the anterior and posterior sagittal diameters. (The films taken at term show hardly enough contrast for satisfactory reproduction.)

The following are the measurements of this pelvis.

Pelvic inlet:	Anteroposterior	$\sqrt{9.5^2 + 6^2}$	= 11.2 cm.
	Transverse	$\sqrt{13.3^2 + 1.5^2}$	= 13.4 cm.
	Right oblique	$\sqrt{10.9^2 + 5^2}$	= 12.0 cm.
	Left oblique	$\sqrt{10.8^2 + 7^2}$	= 12.8 cm.
Plane of least dimensions:	Anteroposterior	$\sqrt{4.7^2 + 9^2}$	= 10.1 cm.
	Transverse	$\sqrt{11.2^2 + 1.5^2}$	= 11.3 cm.
Pelvic outlet:	Anteroposterior	$\sqrt{2.1^2 + 6.5^2}$	= 6.8 cm.
	Bisischial	$\sqrt{11.7^2 + 0}$	= 11.7 cm.
	Anterior sagittal	$\sqrt{1.1^2 + 4^2}$	= 4.1 cm.
	Posterior sagittal	$\sqrt{5.8^2 + 6^2}$	= 8.3 cm.

(Caesarian section was done for threatened eclampsia and at operation the true conjugate was measured and found to be 11 cm., a discrepancy of 2 mm.)

[NOTE: Since sending this in for publication we have acquired a Potter-Bucky diaphragm. We find that the negatives of the pelvis taken with this are very much clearer, and consequently capable of much more accurate measurement.

We are using a universal Coolidge tube at 9 inch parallel spark-gap at about 15 milliamperes, and find that fifteen seconds is a satisfactory exposure for moderate size pregnant abdomens.]

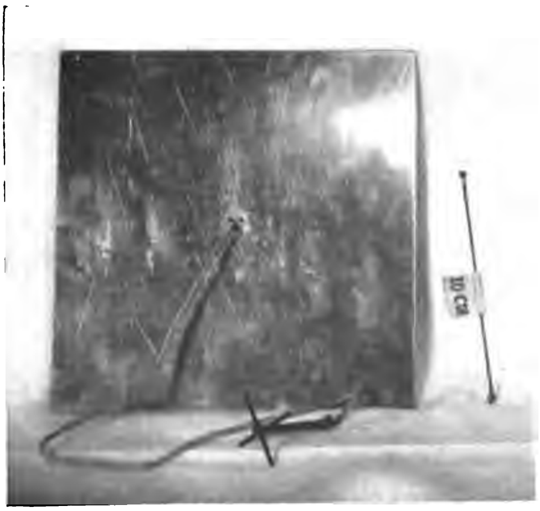

Fig. 5. Filter, Plumb-bob and Control Rod.

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PRESENT PROBLEMS AND FUTURE PROSPECTS OF DEEP ROENTGEN THERAPY*

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WITHIN the past year, one of America's distinguished physicists inquired of the writer whether the roentgen ray had any therapeutic action on tissues other than the skin. This question, propounded in all seriousness by an acknowledged expert in *x*-ray physics, if accepted as indicative of a general lack of knowledge of this work, reflects rather discreditably upon those of us who have been endeavoring to set forth the doctrine of deep roentgen therapy. We have failed either to present tangible facts in convincing form through the medical press, or we have written too much at random and with so apparent a lack of unanimity of opinion as to disqualify our claims.

For some reason, *x*-ray therapy has not kept abreast of diagnosis, and unless we arrive at a certain stage of unification and standardization of the former our efforts will not bear the fruit they should. With this purpose in mind, a brief survey of some phases of this work may be of value. Since it is generally admitted that in certain limited diseases of the skin and appendages, the *x*-ray is an undisputed dominating factor, we shall confine our attention in this discussion to the present day accomplishment of so-called deep roentgen therapy. We shall also touch on what are, in our opinion, the most vital of the problems facing the *x*-ray operator to-day.

In the comparatively recent period in which short wave lengths of *x*-radiation have been produced in working quantities, a mass of valuable therapeutic data has been accumulated. With this as a basis, we can segregate the conditions in which favorable results may be expected, conditions which will uniformly show an end result varying between more or less permanent relief and a clinical cure. As falling within this class, we may roughly enumerate certain glandular and organic diseases. Named in the order of their responsiveness, we would mention localized adenopathies, simple post-infectious, and tubercular. From this list, we are excluding luetic and carcinomatous glands. Next in order are diseases of metabolism due to hypo- and hyper-secretion, those involving the thyroid, thymus, adrenals, and, according to more recent investigations, the pituitary. Hyper-activity of the ovary is very readily influenced and corrected by deep roentgen therapy. The same influence can easily be obtained upon uterine cells, particularly where menorrhagia is a sequence. Fibromata and myomata show a uniformly favorable response in a manner to convince the most skeptical. In the spleen and its associated leukemias we have a stay of the pathological blood changes sufficient to make the effort distinctly worth while. The list of conditions enumerated may be said roughly to include the present day indications for deep roentgen therapy in so far as clinical relief may be expected, and for which up to the present time no other more useful medical agent has been found.

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*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14-17, 1920.

The question will of course be raised: In the malignant forms of internal disease, has the *x*-ray any action which will warrant its use? From a careful perusal of the literature, and a knowledge of the work of many conscientious radiologists, as well as from our own experience, which has extended over a period of many years, we have reached the conclusion that in certain types of internal malignancies roentgen therapy has achieved some success. This is particularly true in carcinomatous glands. Those due to an extension of a malignant process respond more favorably than those due to a true metastasis. Our failure to influence carcinomatous masses has been largely due to our inability to deliver to any particular deep area a lethal dose. This is a problem which the future must solve. There are on record, however, a considerable number of cases of sarcoma, of which we have had several in our own practice, that have been clinically cured by deep roentgen therapy.

As is well known, in carcinoma of the deep tissues, we have had very little encouragement; yet the following case is so extraordinary that it is well worth recording. The patient, male, forty-two years old, with carcinoma involving the lower third of the stomach and the pylorus, inspected through abdominal incision, was declared inoperable and also pronounced malignant by every laboratory and clinical test. He had the usual signs of advanced pathology, pain, cachexia, and rapid loss of weight, and was referred for roentgen treatment as a placebo. The upper abdomen was subjected to intense *x*-ray exposures with heavy filters. In sixty days, the patient had gained twenty pounds, his color was better, his appetite and stomach function greatly improved. *X*-ray treatment has been continued for several months. Nearly a year has elapsed since the exploratory incision. At present, the tumor is no longer palpable, but the tissues on deep pressure feel fibroid and non-elastic. The patient's stomach functionates properly, he retains his normal weight, feels well, and maintains active work. The outlook is decidedly hopeful.

The present day problems of deep roentgen therapy have to deal largely with our ability to deliver a sufficient number of radio-active units to the tissues we wish to influence. With the instruments now available this is acomplished to a certain degree, but we are yet far removed from an ideal which will permit us to deliver at will a known quantity of the energy of radiation to a desired point. In deep roentgen therapy, our first aim is to deliver to the part sufficient radiation profoundly to influence this part, not, as is often the case, merely to a point of stimulation or irritation, but in sufficient force to cause a complete inhibition of pathological cell activity. From a theoretical stand-point, it would seem logical to assume that when a bundle of deeply acting rays pass through cellular tissues of widely different construction and function, both normal and pathological, if such rays are delivered in quantity sufficient to inhibit the action of the pathological cells, the normal structures must suffer equally. Undoubtedly this is true to a degree, yet there is very little evidence that such destruction actually occurs. It must be remembered that we are not referring in these remarks to the European 16-hour technique or to *x*-ray necrosis with secondary destruction due to so-called burns associated with the skin and adjacent tissues. The writer has always assumed that in the soft cellular tissues of the body very little absorption of rays occurs, and that only in congested areas with cellular impaction are the rays absorbed sufficiently to give off the well-known secondary effects, which are the actual working units of ray energy. If this simple hypothesis is accepted it would easily explain why we get an apparent selective action on pathologic structures.

In our work, one of the most important of the problems is the thorough and effectual protection of the skin and its appendages. There is a healthy endeavor in this direction now evident, and our former two or three millimeters of aluminum are now replaced by six to ten millimeters of aluminum. This is highly desirable when working with one hundred kilovolts or more. Another phase of the same problem is the protection of the operator as well as of the patient. Under such high tension work, the patient is frequently better protected than the operator. The usual protective screens, which come as a part of the generating plant, are wholly inadequate. Lead one-half inch thick on three sides of the operator's booth is none too heavy. The lead glass windows in such a cabinet should be in layers to make a one inch thickness. It is doubtful whether any of us take this amount of precaution, but it is most certainly indicated.

Radiologists to-day have a fairly definite idea of what constitutes a safe massive dose, yet there is so great a difference in the technique of the various operators that a definite general formula cannot be adopted. A massive dose through ten millimeters of aluminum filter has an entirely different range of activity from one where four millimeters are employed with the same setting. Again, one using an eight inch focal distance and another ten, with otherwise the same formula, will fall far short of arriving at the same point. The greatest difference in the formulae, however, is in the kilovoltage constant. It is extremely difficult to maintain a consistent ten inch back-up with our present equipment, although this point should be striven for if we are to expect definite effects deep down in the tissues.

Gleanings from the field make it apparent that the average massive deep dose ranges in formulae as follows: Voltage or spark back-up equivalent from 7½ to 10 inches, focal distance 6 to 10 inches, filters 3 to 6 millimeters aluminum, milliamperes on tube circuit 4 to 6, time 5 to 10 minutes. From these various combinations, a very effective deep massive dose could be administered, and on the other hand one of no practical use whatever could also be chosen. In an attempt at standardization, the writer is now engaged in working on formulae based upon the distance beneath the surface we endeavor to reach. Briefly these are as follows: With 3 constants, back-up 10 inches, focal distance 8 inches, milliamperes 5, tissues up to 2 inches below the surface, 4 millimeters aluminum filter, time 7 minutes. This dose may be repeated twice within thirty days over the same skin area. Tissues 4 inches below the surface, 6 millimeters aluminum, time 10 minutes. This may be repeated over the same area twice up to thirty days. Parts 6 inches or more beneath skin, 10 millimeters aluminum, 15 minutes time. This dose may be repeated three times in thirty days. In all this work, an additional cotton filter, one-half inch thick, under compression, is employed. No further exposure is permitted over the same surface within three months.

The future prospects of deep therapy are distinctly encouraging. When we look back upon the comparatively few years in which an effort has been made to separate the wheat from the chaff in *x*-ray therapy, we have strong reasons to be optimistic. No doubt certain improvements in apparatus will soon be developed: First, an electrical generator with unlimited voltage, so constructed as to render the patient's circuit free from danger; second, a controlling device calibrated with a selective system to give any range of penetrability desired; and third, a "Coolidge" tube of sufficient capacity to lend itself in every way to the requirements laid down. If such a development occurs in the not too distant future, the scope and success of deep roentgen therapy will be materially increased. Will such evolution of *x*-ray energy prove a definite cure for cancer? The writer believes not, but he also believes that it will be found in that case to be superior to surgery, and, combined with the latter, will probably be the best method of attack, until the true cause of this terrible disease of modern civilization has been found and conquered.

Addendum: Since this article was written, I am informed that American engineers are perfecting high voltage tubes and transformers of even greater capacity than those in foreign service, and that these will soon be available for our use. This eventuality, of course, will necessitate a complete reorganization of all our present treatment factors.

THE AUTHOR.

GENERAL DISCUSSION FOLLOWING SYMPOSIUM ON THERAPY

DR. G. E. PFAHLER. There has been so much material presented in these papers that it is impossible to discuss everything thoroughly. The work presented by Dr. Levin was of a fundamental character, and will give us principles to work on that do not need so much discussion.

The excellent results obtained by Dr. Hickey in the treatment of papillomata and carcinomata of the larynx are brilliant. You can get, however, good results, too, by the external application of radium or *x*-ray. I have had a patient with carcinoma of the larynx for approximately six years, treated by the *x*-ray alone, cross-firing as much as possible on the disease. I have used the intubation tube, adapted according to the case, for the introduction of the radium inside. The method Dr. Hickey has used of bringing the capsule up from below in the tracheotomy wound is very good. I had thought of doing that, but have never done it. I have a patient at the present time with a tracheotomy wound, and I may carry out that technique when I get home.

I was very much interested in the needle technique described by Dr. Boggs, and I am just as enthusiastic in that as he. I believe that by properly combining the radium with the *x*-ray, we can get more carcinomas of the breast well than by any other means or any other combination. I had a little experience with one case that has been to me most striking, and this patient seemed to be hopeless, even for radiumtherapy, when I started. The patient had been operated on a year before for carcinoma of the right breast. The patient was sent to me with an ulcerating recurrence in the scar, approximately two inches in diameter, with indurated extensions along the scar, and a nodule in the axilla of the operated side, perhaps an inch in diameter. The unoperated breast contained a tumor mass, a group of nodules extending up into the axilla, varying from a half inch to an inch. There was present, also, mediastinal infiltration, presumably carcinoma, extending outward into the lung area. You will admit that is a pretty bad picture. There were also numerous nodules in the supraclavicular region on the left side, which was the side not operated.

I introduced radium needles directly into the carcinoma of the breast and each of the nodules leading up into the axilla, and into the recurrent nodules in the opposite axilla. I made surface application of radium to the nodules in the supraclavicular region, and I made surface application of the radium over the recurrence in the scar. Then I cross-fired with the *x*-ray into the mediastinum through numerous portals of entry. That was started in February. So far as we can see to-day, either by eye, by finger or by roentgenogram, that disease has disappeared. That is more of a result than I believed could have been obtained by a combination of *x*-ray and surgery.

I have used radium needles in some other cases of carcinoma of the breast, but they were of a kind that might have gotten well by other means. I believe this case probably would not have recovered, although I have had some striking results even with the *x*-ray alone, but I am convinced that where you can bring the radium in direct contact with the part, either by direct surface application over a nodule or by introduction of the needle into the disease, you get more pronounced and startling results than by *x*-ray application. It may be because we are using more secondary rays that we get the more pronounced results. However, for the treatment of general surface, or for treatment into the mediastinum, you will get better results by the roentgen rays.

Dr. Kennon Dunham. I should like to ask Dr. Pfahler what are the sizes of the areas of cross-firing in the mediastinum. How large an area can be treated with the *x*-ray?

Dr. G. E. Pfahler (Answering Dr. Dunham). About three inches square. I would like to add a word about cross-firing. I see a great deal of marking up of the chest and cross-firing. Unless you can make that portal of entry bring about an actual cross-fire, you might as well treat two, three or four areas at a time. You must decide, first of all, as near as you can, where your tumor is, and then all your rays should be passed through that tumor area. You ought to arrange the position of your tube, etc., so that your rays go through the tumor. The doctor can do better *x*-ray therapy than the technician, because he is supposed to know anatomy and he is supposed to know pathology, and he is supposed to know where the disease is, etc. It should be his business in each instance to direct his treatment toward that disease.

Dr. George C. Johnston. The statement Dr. Pfahler has just made in regard to cross-firing and the necessity of aiming accurately in the direction of the tumor is, of course, correct, but I would take considerable issue with the statement that radiation directed toward a solid body, such as a patient, even if not directed in the proper axis, would have no effect. It has been well established, I believe, that all the therapeutic effect you get from *x*-ray radiation is due to secondary radiation in the tissue, so it wouldn't make so very much difference if the rays were directed absolutely or not in the proper mathematical direction. I have never been able to convince myself that the filtered gamma rays from radium were directly able to do very much. It is in all probability the secondary radiation set up which has the effect, and the same is true of the highly penetrating *x*-rays. Why do we get so much more effect when we use a highly filtered *x*-radiation with correspondingly less length of application? It may be that it is due to the secondary radiation.

Now, we know that the very radiation that is therapeutically effective is radiographically outlawed. We know that the secondary rays will produce a foggy plate, but these are the rays which are therapeutically effective. Did you ever think about that?

Dr. W. C. Alvarez. I would like to call attention at this point to some ideas again from those worms I talked about yesterday. To my mind, some of the most stimulating work done on the cancer problem has been done by a zoologist, Professor Child. If you wish to get a new outlook on the cancer problem, I would suggest that you read his book on "Senescence and Rejuvenescence" published by the University of Chicago in 1915. There he shows how the original embryonic cells are undifferentiated, that is, they are all about alike and all have the capacity for rapid growth. Later, as they differentiate and take on special functions, they fill up with material which he calls metaplasm. This more or less fixed and dead material increases in amount as the cells grow older; and with its increase, they lose their original power of growth and multiplication.

Finally, a time comes when the cell develops the power of eating up the metaplasm, it de-differentiates, and in so doing regains its original power of rapid growth and fission.

This method of rejuvenescence is naturally of great value to lower organisms, but it constitutes a great menace to the higher animals. I believe that a careful study of this mechanism in the lower organisms may help us greatly in finding the cause and cure of cancer.

The idea of a metabolic gradient comes in in the treatment of cancer. The rapidly growing tumor cells probably have a fast metabolic rate and a large demand for oxygen. We have seen that such rapidly growing tissues suffer more from some poisons than do tissues of slow growth; and the problem of cancer cure, as I see it, is to find some substance which will damage the rapidly growing cells and leave intact the more slowly growing ones of the host. In working towards this end, it would be very helpful to know exactly what the rates of metabolism are in the different parts of the body and in the tumors.

Some of you have asked me for suggestions as to the causes of nausea after roentgen ray treatments. I will say that in the Hooper Foundation, my chief, Dr. Whipple, and some of his associates have been giving large dosages over the abdomens of dogs, and they have found that they can produce deep ulcers in the mucous membrane of the stomach and intestine. If the cone used is a small one the ulcers are small and their edges are sharply limited. If such lesions are produced in man they may account for some of the digestive upsets seen after roentgen ray treatment.

Dr. W. S. Lawrence. I would like to hear a little discussion on the matter of equivalent filtration. This is what brought the thought to my mind. Someone in a paper yesterday said he was using one millimeter of copper and that one millimeter of copper was equivalent to 19 mm. of aluminum. Now if that is true, I would like to know it. Roentgen, in his original paper, stated that the *x*-ray penetrates all materials in proportion to their specific gravity. I do not know that that law has ever been proven false. Now copper is only about three times as heavy as aluminum, and three or four millimeters of aluminum ought to be equivalent to one millimeter of copper.

One other point I would like to suggest: In treating a widespread involvement like the case Dr. Pfahler mentioned, of carcinoma involving practically the whole thorax, and particularly where the lungs are involved, I think the distance method over a large area is a much more valuable method of application than the method of blocking off in small areas, because, as Dr. Pfahler said, in small areas improperly directed, the part below will not get the required amount. Although there is a difference of rays which gives you some cross-fire, even though you direct the central rays at right angles, still the part below the center of one of those areas would get only about what the skin would stand at six or eight inches, according to the distance you select. But if you get twenty inches from the part, and hit a large area, then the part below will get nearly as much as the skin and the effect will be much greater and incidentally you save a great deal of time.

Dr. A. L. Gray. I didn't hear all of Dr. Hickey's paper, but many of the members will recall that at the meeting in Niagara, I reported four cases of laryngeal papillomata treated by the *x*-ray with almost complete success in all four of them. I have since added two adult cases. I would like to know from Dr. Hickey how long he treated this case, and how long he waited after the treatment? My experience with cross-fire radiation in laryngeal papillomata, non-malignant, has been very satisfactory.

Dr. P. M. Hickey. In reply to Dr. Gray's statement, I will state that I waited between three and four years. She had treatments extending over three months, and was also treated elsewhere by the *x*-ray. I tried to bring out in the paper that, from a clinical standpoint, there are two kinds of laryngeal papillomata, one of which is very amenable to surgical treatment, and the treatment I suggested is simply for those intractable cases of papillomata of the larynx. A certain number are very amenable to surgical treatment, and evidently, from the Doctor's remark, to roentgen treatment, also. There is, however, another class which tends to recur very persistently and it is in that class I suggested the contact application of radium to the papillomatous masses.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

H. M. Imboden, M.D., *Editor* · Paul B. Hoebeb, *Publisher*

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY
WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921
Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

SIXTH ANNUAL MEETING THE AMERICAN RADIUM SOCIETY
BOSTON, JUNE 6 AND 7, 1921. HEADQUARTERS, HOTEL BRUNSWICK

WASHINGTON MEETING

The Twenty-second Annual Meeting of The American Roentgen Ray Society will be held in Washington, September 27, 28, 29 and 30, 1921. Headquarters, meetings and exhibits, will be at the Hotel Washington, Pennsylvania Avenue, opposite the Treasury.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of The American Roentgen Ray Society. Mr. A. Gumpert, Manager of the New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him.

The hotel rates are as follows:

Hotel Washington, every room having private bath with shower, tub and running ice water (European plan only):

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Single rooms	$5.00 to $7.00
Double rooms (double bed)	8.00
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Double room without bath, each person	$2.50
Double room with bath, each person,	3.50

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For information regarding the program, those wishing to read papers or to show slides at the meeting should communicate direct with the President, Dr. A. C. Christie, 1621 Connecticut Avenue, N. W., Washington, D. C.

For information regarding commercial exhibits and other business matters connected with the meeting, address the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

It is hoped to arrange for special trains and cars from various sections. Details regarding this will be announced later.

PRELIMINARY ANNOUNCEMENTS

Dr. A. C. Christie, President of the Society, announces that plans for the program of the Annual Meeting of the Society next fall are now well under way. Dr. René Ledoux-Lebard will give the Caldwell Lecture on the subject of "Deep Roentgen Therapy." It is planned to give a much larger place on the program to papers on therapy than has hitherto been done. The plan is to hold the meeting for four days, giving the entire first day to papers on therapy and to have the papers on physics during the forenoon of the second day. This will enable those who are interested only in therapy to leave about the middle of the second day, while those interested only in roentgen diagnosis would not feel it necessary to atend until the beginning of the second day. Those interested in both diagnosis and therapy would probably wish to be present the entire four days.

It is believed that this plan will make the meeting of interest to a much larger number of men. It is requested that those who have papers to present at the meeting communicate with the President of the Society at as early a date as possible.

A. C. CHRISTIE.

WESTERN SECTION

THE AMERICAN ROENTGEN RAY SOCIETY

The second annual meeting of the Western Section of The American Roentgen Ray Society will be held at Portland, Oregon, May 27th and 28th, 1921. The headquarters will be at the Portland Hotel, and the Chairman of the Local Committee on Arrangements is Dr. Roy A. Payne, Stevens Building.

Every facility will be provided for the demonstration of plates and slides. On Friday afternoon time will be taken for an automobile trip over the famous Highway, and the banquet will be held on Friday night, May 27th.

The National Society has been requested to send President Christie to the meeting, and it is hoped that he will be present. One day of the meeting will be occupied by the Western Section of The American Roentgen Ray Society, and the other day by the Pacific Coast Roentgen Ray Society. The following papers have already been promised for the Western Section program:

Super-radiation and Delayed Reactions; Albert Soiland, M.D., Los Angeles.

Postural Variations in Cecum and Colon and their Interpretation; Roy A. Payne, M.D., Portland, Oregon.

Fractured Vertebrae; William B. Bowman, M.D., Los Angeles.

Treatment of Leukemia; H. B. Thompson, M.D., Seattle.

Subject to be announced; Dr. Charles M. Ruggles, San Francisco.

Subject to be announced; Dr. Charles M. Richards, San Jose.

The Pacific Coast Society will have several papers of interest in their Section, and the meeting promises to be very successful.

W. WARNER WATKINS, Secretary.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

GRENZEN DES NORMALEN UND ANFAENGE DES PATHOLOGISCHEN IM ROENTGENBILDE. By Prof. Doctor Alban Köhler, Wiesbaden. Third Edition, revised and enlarged. xi + 415 pages. Illustrated. Published by Lucas Gräfe and Sillem, Hamburg.

It has been a distinct pleasure to review the third edition of Dr. Köhler's book which appeared in May, 1920.

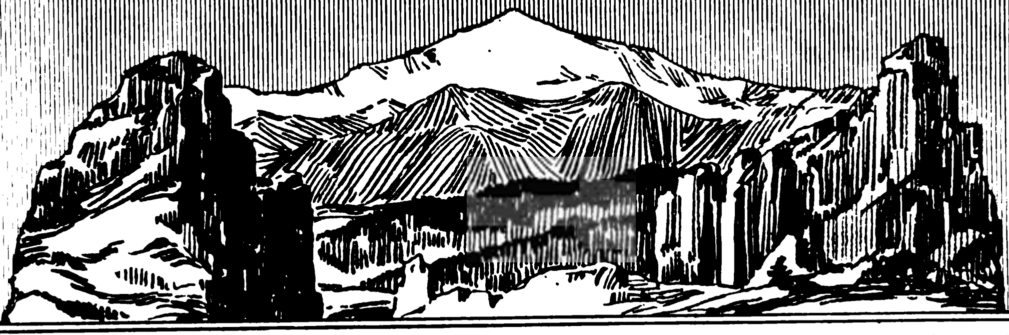
This edition has been enlarged by nearly one third. As it was impossible for Dr. Köhler, during the period of the war, to have access to the medical literature of the world, the revision represents almost entirely the results of his own investigations and experience. There are 415 pages of text introduced by a general part of eleven pages. All sections of the edition have been more or less enlarged, important additions having been made to the general section and the sections dealing with the cardiovascular system, the osseous system and pneumatic cavities. Attention is given to the outlining of growing bone, to inconstant parts of the skeleton, islands in the compacta, general disturbances of growth and to a great number of minor conditions of the skeleton. These are thoroughly described in 238 pages. Sixty pages are devoted to the thorax and 105 to the abdomen. Concerning the gastro-intestinal tract there has been no change made beyond that contained in the second edition. There is a complete index and an extensive bibliography.

The author, in his preface to this edition, calls attention to the illustrations which are tracings of the original roentgenograms, exact to the millimeter, and mechanically reduced in the Academy of Arts. These tracings are excellent in their simplicity without undue elaboration and consequently reveal at a glance the normal condition or lesion they are intended to illustrate.

The object of Dr. Köhler's book is concisely summarized in the title. Its value lies mainly in its descriptions of early pathologic changes and its demonstrations of the wide variations which may exist within normal limits and which are a constant source of error in the interpretation of roentgenograms. Typical lesions have been described and pictured often enough; the great difficulty lies in making accurate diagnoses of early pathologic changes, in view of these wide limits of normal variation.

This excellent discussion of normal and early pathologic processes should be carefully studied by every physician contemplating the study of roentgenology, and even the expert would profit by carefully reading this work, for it presents the very foundation upon which interpretation rests.

R. D. CARMAN.



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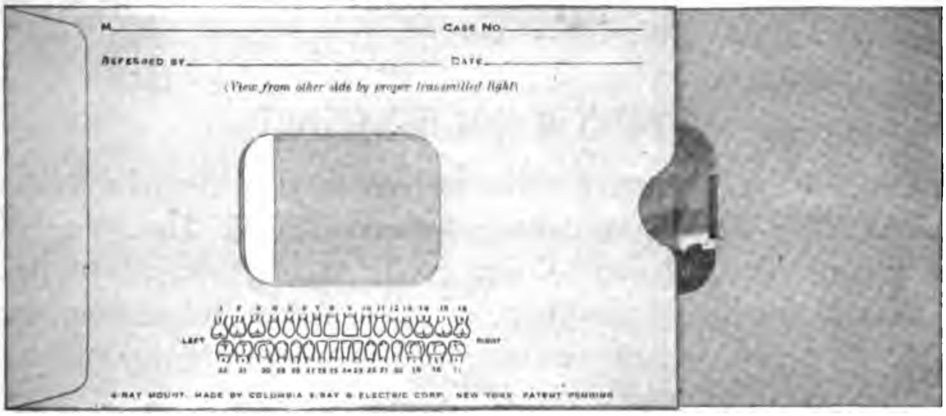
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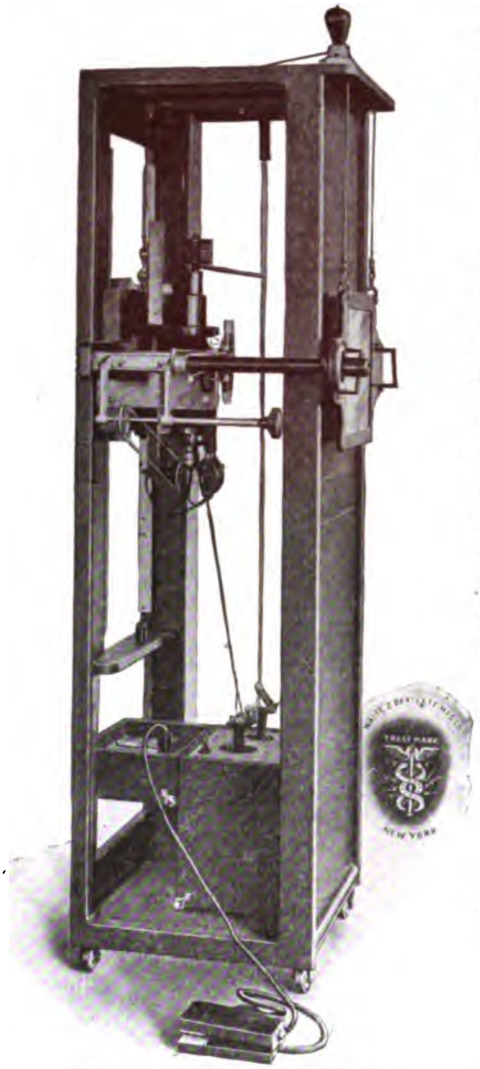

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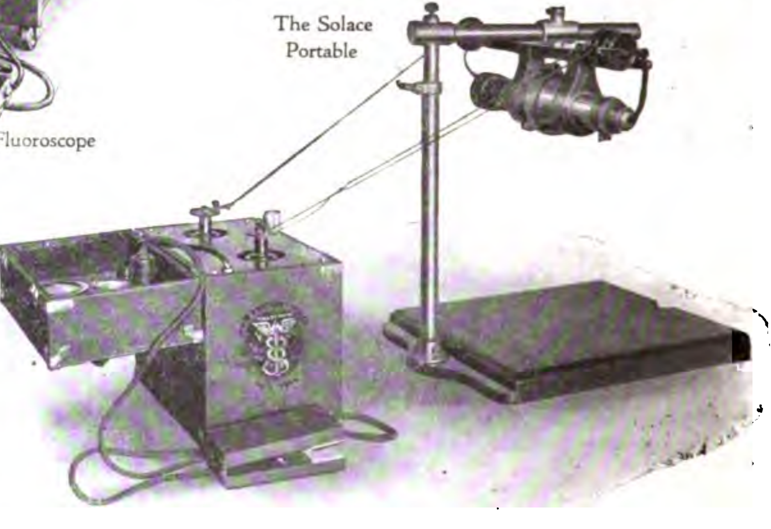

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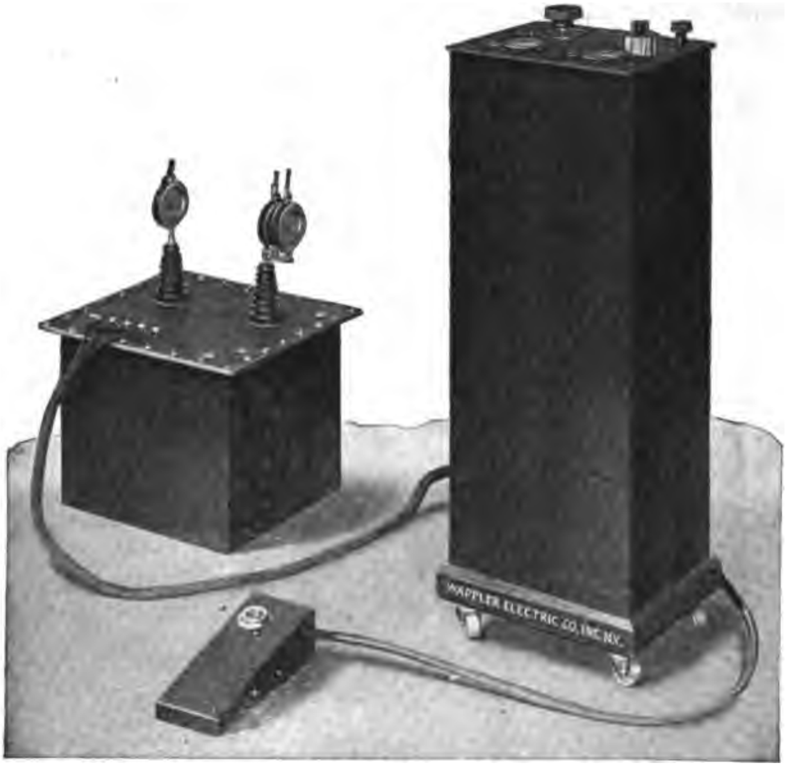

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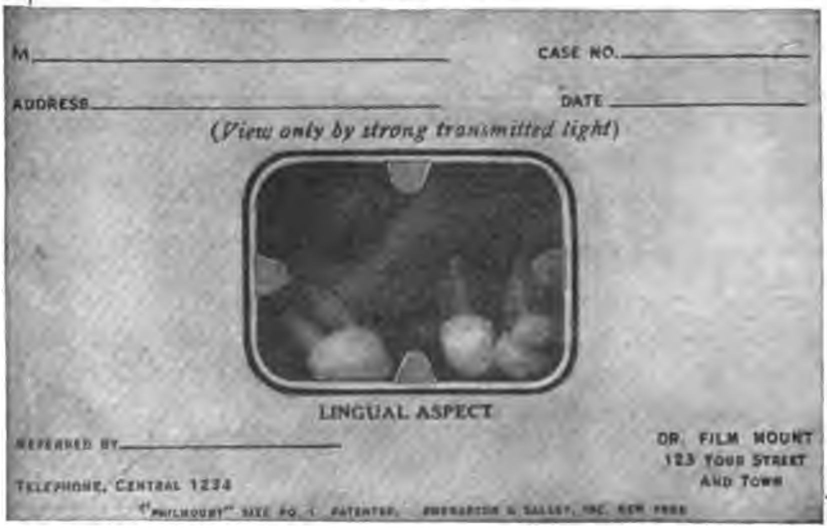

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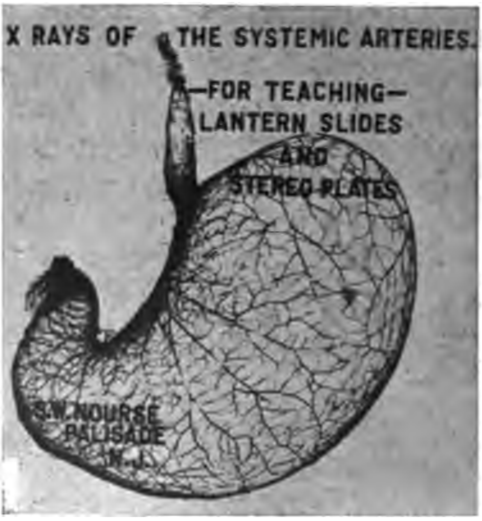

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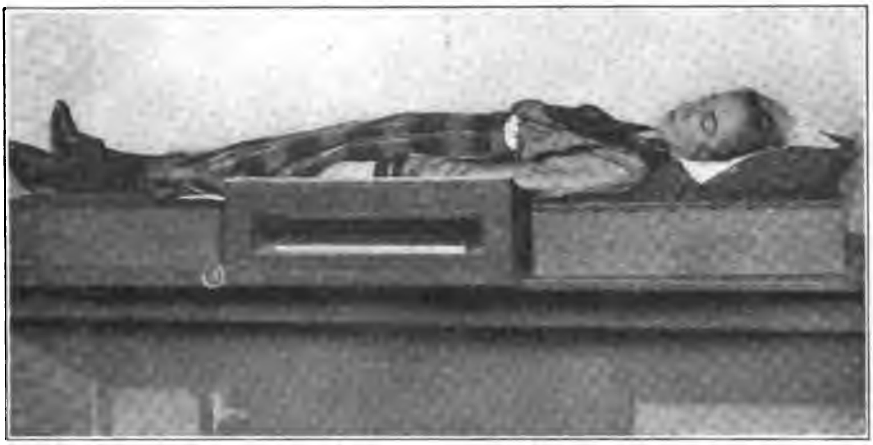

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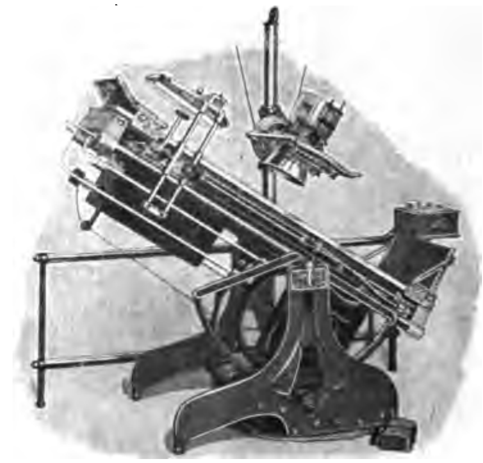

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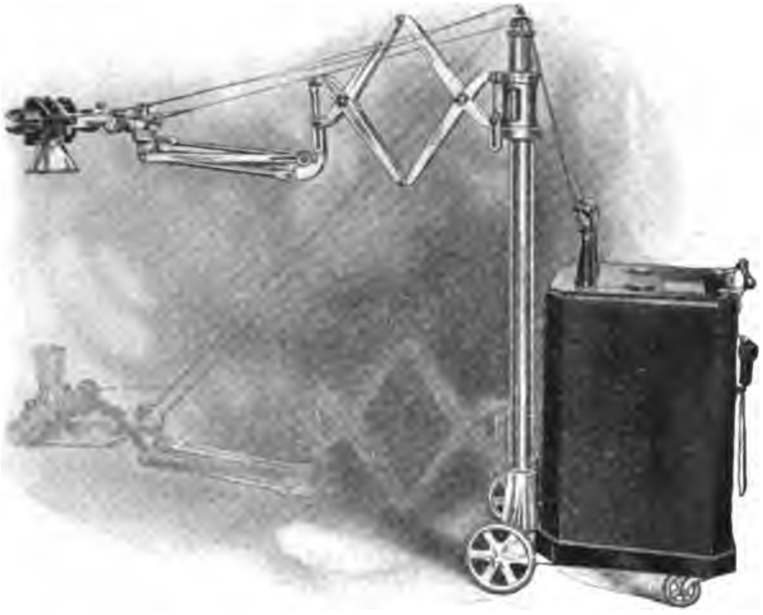

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THE AMERICAN JOURNAL
OF ROENTGENOLOGY

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VOL. VIII (NEW SERIES) JUNE, 1921 No. 6

THE RELATION OF THE SCIENCE OF PHYSICS TO RADIATION THERAPY*

BY HENRY SCHMITZ, A.M., M.D., F.A.C.S.

CHICAGO, ILLINOIS

THE honor you bestowed upon me at the last annual session of the AMERICAN RADIUM SOCIETY by election to the presidency was not expected and was reluctantly accepted. I was aware of the many duties the office would bring and my inability to do justice to its proper representation. The year was hardly on its way, when the various officers and committees began to make preparation for the 1921 session. I observed with a great deal of satisfaction that my office was hardly on its way when the various officers and members of committees had actually incurred a goodly amount of work. It is to their efforts that the sixth annual meeting has been such a great success, and that the scientific part of the program equals that of the preceding meetings. Harvard University, one of the most renowned seats of learning in the world, magnanimously responded to our request for active participation in the scientific proceedings and Dr. Robert Greenough has consented to give a clinic at the Huntington Memorial Hospital to demonstrate the rapid strides radiation therapy is making. I am certain to voice your sentiment in extending to Dr. Greenough and his coworkers, to the officers and committees, the deep-felt thanks and gratitude of our Society. Permit me, also, to take this opportunity to thank you for the honor you have conferred in electing me to the presiding office for the sixth annual session.

Radium therapy and the sister science *x*-ray therapy are entering upon a new era. Empiricism and uncertainty in the therapeutic application of radiation are being rapidly replaced by scientifically correct methods. A biological unit of dose has been defined, measuring instruments have been perfected accurately to gauge the dose, and clinical investigations have progressed so far that lethal dosages for normal and abnormal tissues have been established. Laboratory researches have been continued to investigate the influence of radiations on the blood and blood-forming organs, to interpret correctly radiation sickness or toxemia and to explain their influence on the prognosis of radiation therapy. Much of the progress would not have been made had not the sciences of chemistry and physics and medicine worked hand in hand. History repeats itself. Roentgen, the physicist, discovered the *x*-ray. Madame Curie, the chemist, extracted radium, after Henri Becquerel had detected radio-activity in uranium ores. Scientists and physicians have since labored unceasingly to evolve correct methods of technique and establish laws of indications and contra-indications for the medicinal applications of radiations. The fact that a solution of the many problems of radiation therapy can be reached only by the joint labor of chemist, physicist and physician has been recognized by our Society from the beginning. We are, indeed, fortunate to count among our members the foremost chemists and physicists of our country.

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*Presidential Address delivered at the Sixth Annual Meeting of THE AMERICAN RADIUM SOCIETY, at Boston, June 6, 1921.

TABLE I

Measurements of a 50 mg. Radium Element Capsule. Length 2.28 cm., Filter 1.5 mm. Brass and 5 mm. Celluloid.

a. In Water

Distance in cm.	*Measured Doses in % of Dose at 1 cm. distance*	*Doses Calculated from Absorption and Distance*	*Differences in % of the Calculated Doses*
1	100.		0.
2	23.2	22.5	3.1
3	10.4	9.0	15.6
4	5.4	4.55	18.7
5	3.3	2.62	25.9
6	2.2	1.64	34.1
8	1.2	0.72	66.6
10	0.7	0.39	79.5

b. In Air

Distance in cm.	*Measured Doses in % of Dose at 1 cm. distance*	*Doses Calculated from Absorption and Distance*	*Differences in % of the Calculated Doses*
1	100.	100.	
2	25.	25.	
3	11.2	11.1	
4	6.0	6.3	
5	4.0	4.0	
6	2.6	2.8	
8	1.4	1.5	
10	1.0	1.0	

During the last year I had the opportunity to observe the radiation investigations done in England, France and Central Europe. Of all the various researches carried on I deem those the most important which are concerned with the measurement of radiation. Permit me, therefore, to explain them in detail.

In 1914, B. Szilard of Paris devised an electrometer that was standardized to measure radiation units of uranium. With the instrument it was also possible to measure directly gamma radiations of radium from 1/100 milligram to 500 milligrams without time-consuming calculations. A deflection of the hand of the electrometer indicates the amount of gamma radiation of a radio-active preparation subjected to measurement. W. Friedrich of the Freiburg University perfected an instrument, which is composed of an electrometer and an ionization chamber of 1 c.c. volume. The latter is attached to the electrometer or may be attached to any electroscope by a dielectric cable of any desired length. The ionization chamber is not larger than an ordinary F.30 sound. The advantage of the modification of Szilard's electrometer consists in the possibility of inserting the measuring chamber into body cavities and water phantoms and thus measuring the radiation intensities actually obtained at the seat of the lesion.

Connecting the ionization chamber with a Wilson electroscope Friedrich was able to measure the intensities of radiations at various distances from the source. The measurements were made with a preparation of mesothorium equalling 46.46 radium element gamma radiation and enclosed in a silver capsule of a diameter of 4.6 mm. and a length of 2.28 cm. It was placed in a brass filter of 1.5 mm. wall thickness and surrounded by a celluloid tube of 5 mm. wall thickness to arrest the Sagnac rays effectually. The measurements were taken in water and air and compared with the calculated dose. The differences in the percentages of the measured and calculated doses and those taken in water and air are due to the secondary radiations formed in water. Since the secondary radiations in water are practically of the same value as those in the human body, the deductions apply equally to both. (See Table I.)

In the treatment of diseases it is often feasible to use much larger amounts of radium. Therefore several capsules were placed in filter tubes in a so-called tandem formation. Measurements of such an arrangement showed more or less marked deviations from the values obtained from the single capsule. These mesothorium capsules, each of a radium element content of about 50 mg. and a length of about 3 cm., were placed in a brass filter tube of a length of 8.28 cm. and wall thickness of 1.5 cm., surrounded with a celluloid tube of a wall thickness of 5 mm. The measurements were taken at various distances in a vertical direction from the center of the longitudinal axis in water as well as in air. The results are shown in Table II.

TABLE II

Measurements of Three 50 mg. Radium Element Capsules. Length 2.25 cm., Filter 1.5 mm. Brass and 5 mm. Celluloid.

a. In Water

Distance in cm.	*Measured Doses in % of Dose at 1 cm. distance*	*Doses Calculated from Absorption and Distance*	*Differences in % of the Calculated Doses*
1	100.	100.	0.
2	32.4	22.5	44.0
3	15.7	9.0	74.5
4	9.3	4.55	104.5
5	5.6	2.62	113.5
6	4.2	1.64	156.0
8	2.4	0.72	233.5
10	1.5	0.39	285.0
b. In Air			
1	100.		0.
2	30.5	25.0	22.0
3	15.0	11.1	34.9
4	9.3	6.3	48.8
5	6.3	4.0	57.6
6	4.6	2.8	67.0
8	2.6	1.5	66.5
10	1.6	1.0	60.0

If the source of radiation be a point or ball-like body of equal dimensions all around, then the planes of like doses, termed standard or isodoses by Friedrich, surround the source of radiation concentrically. The radium tubes which we use in deep therapy are of a cylindrical shape. One might assume that the planes of isodoses would form parallel with and cylindrically around the tubes. However, if actual measurements are taken in water for both preparations, that is, the one tube and three tube arrangements, the results of the measurements as given in Tables III and IV are obtained.

Having made these determinations Fried-

TABLE III

Measurements of 50 mg. Radium Element Capsule. Length 2.28 cm.

Distance in cm.	*Doses Measured in Center Vertically to Long Axis*	*Doses Measured at End Vertically to Long Axis*	*Doses Measured in Direction of Longitudinal Axis*
1	100.0	70.	25.
2	23.2	20.	9.4
3	10.4	9.0	5.0
4	5.4	5.0	3.2
5	3.3	3.1	2.1
6	2.2	1.9	1.4
8	1.2	0.9	0.8
10	0.7	0.5	0.5

TABLE IV

Measurements of Three 50 mg. Radium Element Capsules. Length 8.25 cm.

Distance in cm.	*Doses Measured in Center Vertically to Long Axis*	*Doses Measured Vertically to Long Axis Midway Between Center and End*	*Doses Measured at End Vertically to long Axis*	*Doses Measured at End in Direction of Long Axis*
1	100.	61.5	36.4	19.5
2	32.4	22.7	14.7	7.8
3	15.7	11.7	8.9	4.5
4	9.3	7.4	5.4	2.8
5	5.6	4.9	3.9	2.2
6	4.2	3.1	3.0	1.6
8	2.4	1.8	2.0	1.0
10	1.5	1.3	1.3	0.4

rich could now proceed to ascertain the isodoses for radium preparations of the same length, i.e., 2.28 and 8.28 cm. If the radiation intensity is assumed to be 100 per cent at a distance of 1 cm. in an axis drawn vertically to the center of the longitudinal axis, then the percentages 90, 80, 70, 60, 50, 40, 30, 20, 10, 5 and 2 give the curves for isodoses, as seen in Figures 1 and 2 below.

Thus we gain from the researches of a physicist a correct idea of the actual intensities of radiations. The therapeutic application of these values has been worked out by

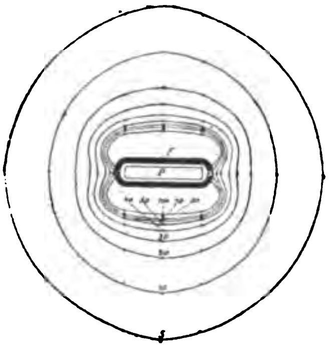


Fig. 1. Curves of Isodoses of a Radium Capsule of a length of about 3 cm. [Friedrich].

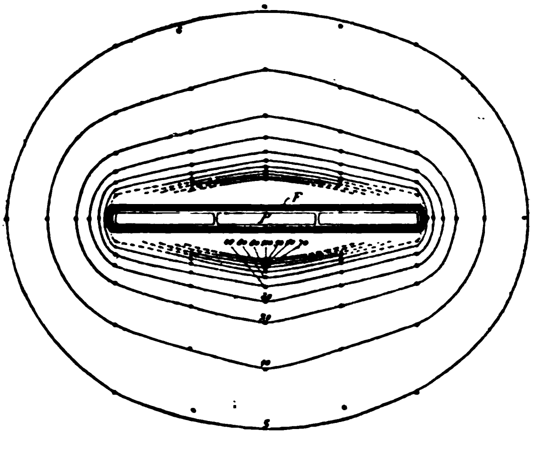


Fig. 2. Curves of Isodoses of Three Radium Capsules of a total length of about 9 cm. [Friedrich].

Opitz and Friedrich. The iontometer expresses radiation values in electrostatic units, shortly designated by a small "e." If a capsule of radium containing 30 mg. element filtered through 1.5 mm. of brass and 5 mm. of celluloid is applied to the skin at a distance of 1.5 cm. the application to produce necrosis of the skin must be extended to seventy hours, i.e., 2100 mg. e hrs. This measures 300 e. Hence 7 mg. e hrs. would equal 1 e.

If we refer to the tables and figures of isodoses, we see that, if a 50 mg. radium element capsule be used, the dosages at various distances for an hour's application are as shown in Table V.

TABLE V

Isodoses for Various Distances and Time Durations.

Distance in Cm.	*% of Isodoses*	*% of E.S.D. of 50 mg. Ra. El.*	*% of "e" Units*
1.5	40	100	14.2
2.3	20	50	7.1
3.4		25	3.55
4.7	5	12.5	1.78
5.6	2	5	0.71

Exposure of

Distance in Cm.	*10 Hrs.*	*20 Hrs*	*30 Hrs.*	*40 Hrs.*	*50 Hrs.*	*60 Hrs.*	*70 Hrs.*
1.5	71.0	142.0	213.0	284.0	355.0	426.0	497.0
2.3	35.5	17.0	106.5	71.0	177.5	213.0	248.5
3.4	17.75	35.5	53.25	142.0	88.75	116.5	114.25
4.7	8.9	17.8	26.7	35.6	44.50	53.4	62.30
5.6	3.55	7.1	10.65	14.2	17.75	21.3	24.85

Let us apply these observations to a practical example, for instance a cervical cancer.

The limits of the diseased area in cases that can be considered to be benefited by radiations are identical with the lateral bony pelvic walls, the pelvic inlet above, the pelvic outlet below. The axis of the cervix lies in the axis of the true pelvis. The uterus, adnexa and regional lymph glands are contained within the true pelvic cavity. The antero-posterior and transverse diameters measure 12 and 13 cm. respectively. A radium capsule of 50 mg. element will therefore give isodoses as indicated above and we at once know the exact intensities that may be obtained in any part of the true pelvis.

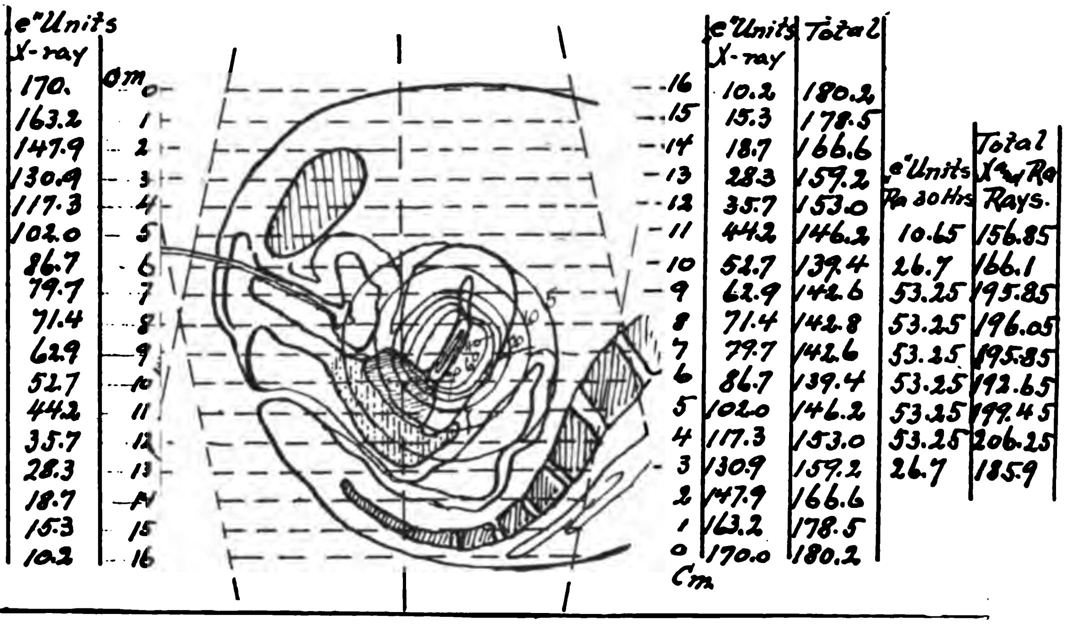
The question arises, How may we apply these results in therapy? Obviously a biologic unit of dose must first be ascertained that may be exactly reproduced by any one using radiations; secondly, comparative doses of normal and abnormal tissues must be determined and expressed in a known quantity.

The normal skin reacts to a dose of 160 to 170 e, with a mild inflammatory change characterized by the appearance within eight to ten days following radiation of an erythema and subsequent desquamation, and after three to four weeks by epilation and brownish discoloration of the skin area. This reaction has been termed an erythema dose (abbreviated E.S.D.). It is the standard of comparison for all other tissues and radiation reactions. A destructive reaction seen as blistering and subsequent necrosis of the skin is obtained with a radiation dose of 300 e, and is known as the death skin dose. It is, therefore, produced by about twice a dose of the E.S.D.

A radiation of the ovaries to produce amenorrhea is produced by 33 e; a cancer dose to cause visible and palpable resorption of the tumor and local healing within six to eight weeks by 150 e. The erythema dose for the rectal mucosa appears to be 200 e, for the mucosa of the urinary bladder about 200 e. The sarcoma dose is 120 e, the muscle tissue dose 300 e, and the tuberculosis dose 100 e (Seitz and Wintz, Opitz and Friedrich).

The object of the radiation of uterine cancer is to cause degeneration or death of all carcinoma cells contained within the true bony pelvis without causing irreparable injury of the vital structures and organs a sufficiently large dose of radiation that will be lethal beyond a distance of 3 cm. if we wish to avoid irreparable injury to rectum or bladder.

Various procedures have been advised to overcome this deficiency, such as longer continued intra-uterine radiations irrespective of any detrimental consequences to rectum and bladder, the insertion of needles or trochars containing radium into the parametria, the application of radium packs containing up to one gram of radium element over the suprapubic regions, and the roentgen ray. It is obvious that the solution of the problem



e"Units X-ray	Cm
170.	0
163.2	1
147.9	2
130.9	3
117.3	4
102.0	5
86.7	6
79.7	7
71.4	8
62.9	9
52.7	10
44.2	11
35.7	12
28.3	13
18.7	14
15.3	15
10.2	16

Cm	e"Units X-ray	Total	e"Units Ra 30 Hrs	Total X and Ra Rays.
16	10.2	180.2		
15	15.3	178.5		
14	18.7	166.6		
13	28.3	159.2		
12	35.7	153.0		
11	44.2	146.2	10.65	156.85
10	52.7	139.4	26.7	166.1
9	62.9	142.6	53.25	195.85
8	71.4	142.8	53.25	196.05
7	79.7	142.6	53.25	195.85
6	86.7	139.4	53.25	192.65
5	102.0	146.2	53.25	199.45
4	117.3	153.0	53.25	206.25
3	130.9	159.2	26.7	185.9
2	147.9	166.6		
1	163.2	178.5		
0	170.0	180.2		

Fig. 3. Median Longitudinal Section of Pelvis showing the Intensities of *X*-rays for each Centimeter and the Isodoses of the Radium Capsule Inserted into the Uterine Canal. [After Opitz and Friedrich.]

within this area. If we refer to Figure 3 we see that the rectal mucosa receives an isodose of 10 per cent, while the bladder mucosa lies within the isodose of 20 per cent. Hence we must not extend the application of 50 mg. of radium element to more than fifty consecutive hours, otherwise the bladder will be severely damaged. The dose obtained at the bony pelvic periphery is, however, so minimal (17.75 e) that instead of arresting the growth of the cancer in this location, the rays will stimulate the cancer. The conclusion must be drawn that we can never apply must be one that may be used in every hamlet of our country. We must strive to enable as many cancer patients as possible to obtain the benefits of radium treatment. Roentgen laboratories are connected with almost all hospitals. Fifty or one hundred milligrams radium element could easily be obtained by a group of interested medical men.

May a combination of radium and roentgen ray therapy improve the outlook for the the patient? Again the physicists are showing us how to proceed. Coolidge and his associates, the large European clinics, with the cooperation of physicists such as Friedrich at Freiburg, Wintz and Voltz at Erlangen, Item at Berne, have measured the absorption curves for the different qualities of *x*-rays.

Through the kindness of Dr. Coolidge and the Victor X-Ray Corporation I have been supplied with a measuring instrument. By means of it I have made actual measurements in the living subject. The values obtained are shown in Figure 3. The clinical application of the *x*-ray is performed as follows:

An exact median longitudinal section is made measuring the distance from the anterior body surface to the posterior surface and from the anterior surface to the cervix and from the posterior surface to the cervix, as seen in Figure 3. Lines 1 centimeter distant are drawn across. The *x*-ray intensities are entered for each centimeter, to the left those obtained through the anterior portal of entrance, to the right those through the posterior portal of entrance. A summation of both is entered in the second column to the right. It will thus be seen that the radiation intensities between the fourth and twelfth centimeters lack intensity values of 20 to 30 e, 170 e being the required and permissible intensity. A thirty hours' application of fifty milligrams radium element will increase the deficient intensities as follows:

At 5 cm. $146.2 + 10.65 = 156.85$
At 6 cm. $139.4 + 26.7 = 166.1$
At 7 cm. $142.8 + 53.25 = 195.85$
At 8 cm. $142.8 + 142.0 = 284.8$
At 9 cm. $142.8 + 284.0 = 426.8$
At 10 cm. $139.4 + 142.25 = 285.65$
At 11 cm. $146.2 + 106.5 = 252.2$
At 12 cm. $153.0 + 53.25 = 206.25$
At 13 cm. $159.2 + 10.65 = 169.85$

At the anterior rectal wall the intensity is $146.2 + 53.25 = 199.45$, at the fundus of the urinary bladder $142.8 + 53.25 = 196.05$. It is seen, therefore, that the lethal dose has not been exceeded at these organs except within the limits of the uterus. This organ will become destroyed.

The exhaustive researches on radiation intensities carried on by the physicists have enabled the clinician to work out a technique that conforms to the most important requirement of cancer therapy, namely, the carcinoma must be traversed by a homogeneous radiation intensity that can cause all the cancer elements to degenerate without doing irreparable damage to the vital structures contained within this area. The future will tell us whether by this technique the prognosis of the cancer disease will be improved. The primary results obtained are better than those from the sole use of radium.

The object of the presentation of these investigations is to induce the members of the Society to carry on researches along the same line. Without the collaboration of the physicist it will be almost impossible. The empirical methods of stating radium dosage in milligram element hours and *x*-ray dosage in milliampere minutes, the practice of calculating the dose from the laws of absorption and distance without considering secondary radiations, are obsolete and unscientific. Whether the biological reaction of the secondary radiation equals that of the primary *x*-ray and gamma ray radiation is also a disputed question.

In perfecting the technique of radiation therapy we must not overlook other equally important questions that await classification and solution, such, for example, as further histological evidence of the changes in radiated tissues, which will solve the much-debated question of the supposed differences in sensitiveness to radiations of cancers of different cell structures; the reaction of the blood and blood-forming organs and the metabolic disturbances in radiated patients. Finally the study of the nature of the toxemia or radiation sickness must be investigated to establish its value either as a contributive curative or as a detrimental factor to the patient's chances of recovery. The problems are many. Yet the evident desire for investigation shown by all the members of this Society will lead to an early solution of these interesting problems.

X-RAY TREATMENT OF HYPERTROPHY OF THE PROSTATE*

By SAMUEL STERN, M.D.

Radiotherapist to Mount Sinai Hospital, and Chief of the Radiotherapy Department of the Mount Sinai Dispensary

NEW YORK CITY

X-RAY therapy of hypertrophy of the prostate gland has been carried out for a number of years. The reports that have appeared in medical literature from time to time, so far as the results are concerned, have not been very enthusiastic. They all agreed that it had a beneficial influence upon the prostatic bleeding and pain, and upon the frequency of micturition, but they thought that it had very little if any influence upon the size of the prostate and upon the amount of residual urine. They considered the treatment as chiefly indicated in the early cases, during the waiting period, and that all it may accomplish is to make these patients a little more comfortable until they reach the stage where operation would become imperative.

I think this is entirely too pessimistic a view of the situation. At least I feel that the results accomplished in a number of cases which have been under observation for five or more years justify the belief that in many instances we can do better than merely expect a temporary relief from the more distressing symptoms.

For instance: One of my patients, a man sixty-six years old at the time he was referred to me, six years ago, was advised to have an immediate operation. He had a fairly large sized prostate which gave considerable annoyance in the form of pain and very frequent micturation. Under *x*-ray treatment these symptoms disappeared promptly and have not returned up to date. He is now seventy-two years old and, so far as symptoms are concerned he is not aware of the fact that he has a prostate. Examination shows the prostate to be still enlarged, but it feels softer and is much less sensitive. In the case of a physician who was referred to me five and a half years ago at the age of sixty-four with a large prostate and the accompanying pressure symptoms, with occasional difficulty in starting micturition, the results have been equally good. He assures me that he has not the slightest trouble and that his nights are practically undisturbed. In another case referred to me five years ago at the age of sixty-seven, the patient was on the waiting list for admission to the hospital to be operated upon. His general condition was rather poor, and the surgeon was reluctant to operate, but thought it the only chance of relief. This patient had some prostatic bleeding and a great deal of discomfort and pain. These symptoms yielded promptly and the patient has not the slightest prostatic annoyance to-day.

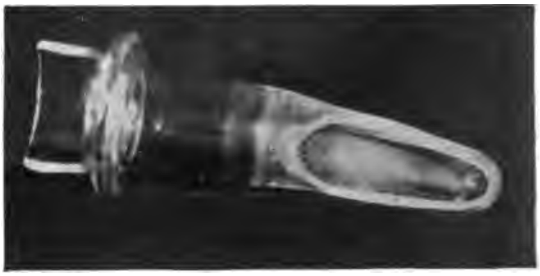


FIG. 1. Lead glass speculum with opening to fit over prostate.

Whether there is a real diminution of the size of the prostatic gland of these patients, or whether there is merely a subsidence of the chronic inflammatory condition accompanying the hypertrophy, is very difficult to determine.

In most cases there is a softening, diminished sensitiveness, and a diminution of the size of the prostate palpable, but all this may be readily explained by the subsidence of the inflammation. After all, probably with advancing years a certain amount of hypertrophy of the prostate is physiological and it is perhaps the accompanying chronic inflammatory condition that is responsible for most of the symptoms. Consequently if we can through x-ray treatment influence this condition, we are in a position to do a great deal for these patients.

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* Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 28, 29, 1921.

Knowing the effect of the rays upon glandular tissue, it is difficult to see why there should not be an actual diminution of the gland itself, and I feel quite sure that there must be. We know with certainty that in myoma, which is practically the same type of tissue as that found in these adenomas, there is a diminution, even to the extent of disappearance at times. At any rate, I have found that the majority of cases in which x-ray treatment was begun before the condition was too far advanced have progressed well and have escaped operation.

Choice of Cases.—The most favorable cases for x-ray treatment are the early ones, those that come to the physician complaining of occasional pain and discomfort in the prostatic region, with frequent micturition, possibly with slowness in beginning micturition or prostatic bleeding. Cases that are far advanced—those that have already entered the catheter life—have not done well. We may improve their subjective symptoms but I have not been able to get them to resume voluntary micturition. After they reach the stage of regular periodical catheterization they have learned to depend on this entirely, and either through a mental hazard or on account of paralysis of the bladder muscle they do not seem to be able to resume their normal function even if the prostate becomes softer and the inflammatory condition is relieved. Cases that are complicated with cystitis are not improved until that condition is treated in the usual way.

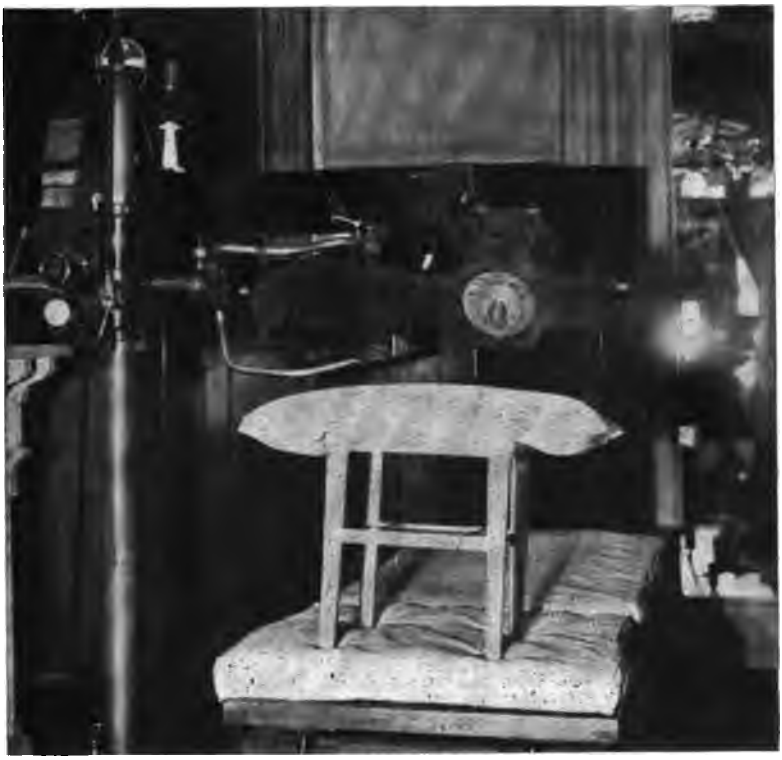


FIG. 2. Inclined tube-stand with lead glass attachment into which end of speculum fits.

Technique.—This is very important. The results depend entirely upon the proper application of the rays. The method I have used in treating my cases is as follows:

As port of entry, I use the rectum, with direct application upon the prostate and the perineum. The patients are put in the knee-chest position. A blind pouched lead glass tube (Fig. 1), with an opening to fit over the prostate, is inserted into the rectum. The tube is covered with a thin rubber finger cot to prevent the edges from injuring the mucous membrane.

The tube-stand, with the proper filters in position and a small lead glass tube attached (Fig. 2) is now approximated to the lead glass speculum so as to make a continuous channel (Fig. 3).

The stand is tilted so that the rays will strike the prostate at a direct angle. Care is taken that as the speculum is inserted at each treatment the oval opening is applied over a different lobe of the prostate.

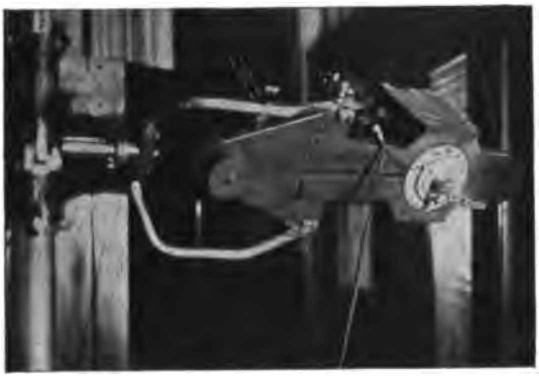


FIG. 3. Inclined tube-stand with lead glass speculum approximated.

In treating through the perineum, the small lead glass tube on the stand is put in direct contact with the perineum.

Dosage.—These patients are treated in series. Four weekly applications to the prostate and perineum are considered as one series. This is followed by an interval of one month, when the second series is given.

If there is a marked improvement at the end of the second series, the interval of rest is prolonged to two months before the third series is given. If not, it is given at the end of one month.

After three series have been given the interval of rest between applications should be at least two months. The number of series will depend upon the results accomplished. As a rule, there should be a decided improvement at the end of three series. If there is no change in the patient's condition at the end of this time, it is probably useless to continue with further treatments.

After the symptoms have subsided and the patients have been made thoroughly comfortable, the treatments are discontinued, but as a prophylactic measure I have found a great deal of benefit in giving these patients one series of treatments at intervals of six months over an indefinite period. This is undoubtedly worth while, and if your patients belong to the intelligent classes they will gladly submit to it. They have such a wholesome fear of the recurrence of their discomfort and of the possibility of an operation becoming necessary, that they will rather look forward to the treatments.

The amounts of ray given in my cases were as follows:

Time	*Distance*	*Spark gap*	*Ma.*	*Filter*
5 m.	Perineum, 7½ in. Prostate, 9½ in.	9 in.	5-6	4 mm. Aluminum

The difference in the distance used between the perineal and prostate applications is due to the difference in the length of the lead glass speculum used.

This dosage, applied in a series as above described, should not produce an erythema at any time during the course of the treatments—at least it has not done so in any of the cases I have treated.

SUMMARY

1. *X*-ray treatment of hypertrophy of the prostate is of decided value, and should be given a trial in all the early cases.
2. Many of the cases so treated will not only be temporarily benefited but may escape operation altogether.
3. Cases far advanced, those that have reached catheter life, will be only temporarily and subjectively benefited by the treatment.
4. Prophylactic *x*-ray treatments, to safeguard against recurrence of symptoms in improved cases, are undoubtedly of value and should be carried out in every case.

ROENTGEN RAY CARDIAC STUDIES

BY CHARLES L. MARTIN, E.E., M.D.

DALLAS, TEXAS

THE literature of the past twenty years has contained many excellent contributions covering both the normal and the abnormal roentgen ray appearances of the heart. Dr. Williams[1] of Boston published an article on this subject in 1899, and much was written in German during the early years of the twentieth century. However, the American literature has been devoted more to the discussion of technique and to the study of the normal heart, and it is for this reason that the author is presenting a series of tracings from teleroentgenograms of the chests of patients suffering from actual cardiac conditions. This brief article can in no way compare with the excellent works of such eminent men as Groedel[2] and Vaquez and Bordet[3], but it will perhaps emphasize the practical value of the roentgenogram in the field of cardiology.

TECHNIQUE

Arguments for and against the various techniques tend to carry one far afield, and it has been thought best merely to describe the methods used in studying the cases which are to be presented. These methods are fairly simple and can be executed in a reasonbly short time. They constitute the routine cardiac examination which has been used by the Roentgen Ray Department of the Massachusetts General Hospital for many years and which is fully described by Holmes and Ruggles[4].

The patient first stands facing the observer, with his chest against a fluoroscopic screen of sufficient size to make possible the visualization of all of both lung fields. Tracings are made of the cardiac outlines and the upper and lower limits of excursion of the diaphragm during normal respiration, care being taken to indicate the point of junction of the left auricle with the left ventricle. The patient is then asked to hold his breath in both forced inspiration and forced expiration, while tracings are made of the positions of the domes of the diaphragm and of the left border of the heart. The patient's left hand is next placed upon the top of his head and he is turned to his left until the shadow of the great vessels assumes its narrowest transverse diameter. At this point a tracing of the outline of the great vessels is made and the lower posterior mediastinal space is carefully studied in full inspiration to determine whether or not it is obliterated by the shadows of enlarged auricles or a pericardial effusion. Abnormalities in pulsation are noted on a sheet provided for the purpose. The examination is completed by taking a teleroentgenogram with the anterior portion of the patient's chest held squarely against a cassette. The target of the tube is placed at a distance of seven feet from the cassette and centered on a level with an imaginary line drawn through the scapulae some 2 inches above the lower tips of the angles.

After the roentgenogram is developed, it is marked off with a soft lead pencil as shown in Figure 1, which represents the anatomical divisions of the cardiac shadow. If the shadows of the inner ends of clavicles exactly span the shadows of the bodies of the upper thoracic vertebrae, the plate has been correctly made and is suitable for mensuration. Otherwise it should be discarded, because a slight amount of rotation causes a considerable error in the measurements. The center line is drawn through the center of the shadows of the spinus processes of the vertebrae. "MR" and "ML" represent the distances to the right border and to the left border ordinarily percussed out by the internist. The line "L" is drawn from the point of junction of the right auricle with the right border of the ascending aorta to the apex. Quite often the apex cannot be made out in the roentgenogram. This is particularly true where the diaphragm is high, as in obesity. In such cases it is necessary to continue the curve of the left ventricle downward and to the approximate position of the apex. "X" is drawn perpendicular to the line "L" from the point of junction of the right auricle and right diaphragm. This point is often not sharply defined, but a slight error in locating it will make very little difference in the length of "X". "Y" is drawn perpendicular to the line "L" from a point on the border of the left auricle appendage. The limits of this appendage cannot be made out on the average roentgenogram of the normal heart, but the length of "Y" will not vary appreciably if the point be selected anywhere along the approximated border of this structure. It is evident that "X" plus "Y" or "B" is the dimension which is increased with enlargement of the auricles, while "L" is more likely to be increased with ventricular enlargement. The dimension marked "Gt. Vs." extends from the right border of the ascending aorta to the left border of the descending aorta, and represents the width of the aortic arch. In some cases the left border of the descending aorta is obliterated by the shadow of the pulmonary artery or left auricular appendage and in such cases the dimension "Gt. Vs." represents the width of the great vessels. It must be remembered that the right border of the shadow of the great vessels is in reality the right border of the ascending aorta, since the superior vena cava casts little or no shadow. In addition to these measurements, it is wise to lay off the internal transverse diameter of the chest.

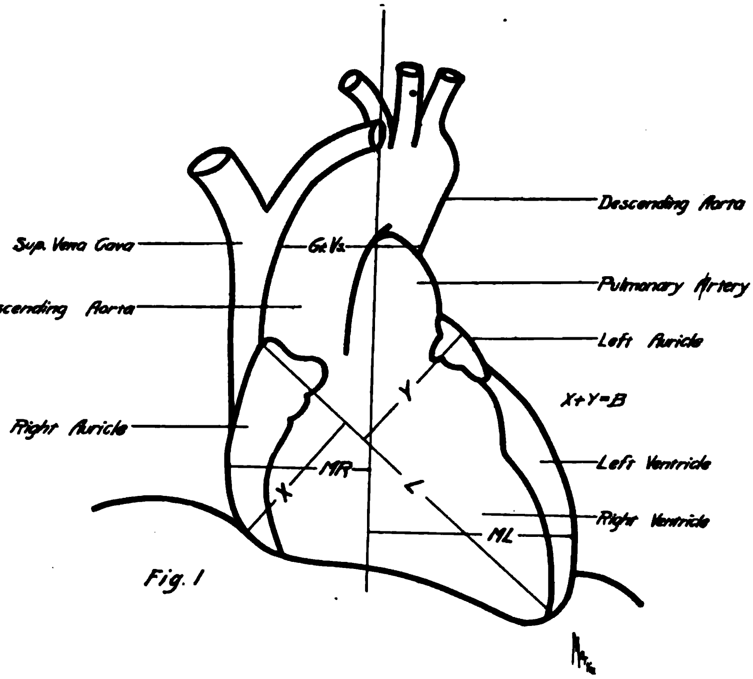


Fig. 1

VALUE OF THE EXAMINATION

From the examination as outlined above, it is possible to determine the size and shape of the heart and also to determine whether it moves with respiration. The study of pulsations is often disappointing because the excursion of the cardiac borders is so slight that variations are made out with difficulty. According to Groedel, the excursion of the left border of the left ventricle with each heart-beat rarely exceeds two millimeters.

The size and shape of the structure are the most important factors and they can both be determined from the seven-foot plate, although the fluoroscope brings out variations in shape much better because of distortion. Many good cardiologists now admit that percussion of cardiac outlines is often not a reliable procedure. Danzer[5] has recently called attention to the fact that Thomas Lewis is now using the apex beat in approximating the size of the heart. The same author points out the possible sources of error in such a method and insists on the use of the roentgen ray. Dr. George C. Shattuck[6] demonstrated the inaccuracy of percussion in cardiac work at the Massachusetts General Hospital in 1916, and published an excellent article on the subject at that time. It is now rather generally conceded that the dimensions obtained from the roentgenogram are accurate, but the chief difficulty arises in determining whether the individual heart in question is too large for the patient possessing it. Many tables of normals have been constructed, but they seem to show rather wide variations for each class of individuals listed. In a word, when depending upon tables, it is often necessary to say that the dimensions of a certain heart are at the upper border of normal or, perhaps, a little greater than normal, while the patient seems perfectly well and the roentgenologist hesitates to state definitely that there is real cardiac enlargement present. After applying it to a fairly large series of cases, the author has arrived at the conclusion that the cardiothoracic ratio, as recently advocated by Danzer, gives as much information concerning the size of the heart as do the various tables. Cohn,[7] after examining a series of soldiers, is in full accord with this statement. When using this method, the structure is said to be definitely enlarged when the total transverse diameter, that is, "MR" plus "ML," exceeds one half of the internal diameter of the chest. This ratio is expressed as the quotient obtained by dividing the transverse diameter of the heart by the internal diameter of the chest and can be determined very rapidly without the aid of tables. If only the transverse diameter is needed for this determination, it may seem unnecessary to go further with mensuration, but a study of the following cases will show that the relative values of the measurements "B", "L" and "Gt. Vs." give information of value in certain cardiac disorders. In order to present this work in an orderly fashion, the diseases of the heart will be considered under the headings of the hypoplastic heart, pericarditis, myocarditis, valvular disease, cardio-renal disease, and diseases involving the great vessels. This classification does not include the arythmias or congenital diseases of the heart, because only a very few such cases were studied. All of the congenital cases seen showed cardiac enlargement. All of the drawings, with a few exceptions, were made by tracing the outline of the heart, great vessels, diaphragm and lung fields from the finished teleroentgenograms of actual cases. All the diagnoses, histories and physical examinations except one were taken from the records of the Massachusetts General Hospital.

THE HYPOPLASTIC HEART

The determination of the presence of a hypoplastic or small heart sometimes frees a patient from a restricted cardiac life imposed upon him by some well-meaning physician. Figure 2 represents such a case. The patient had been turned down for the draft because of a definite systolic murmur heard over the precordium. The well-informed clinician now pays little attention to a systolic murmur unless it be accompanied by cardiac enlargement, and when the heart is unusually small, as in this case, the patient may be told with a fair degree of assurance that he has no chronic organic heart disease. It is true that persons who have such small hearts often exhibit the so-called effort syndrome which is so clearly described by Thomas Lewis in his little book bearing that title. Bertnard Smith[8] has recently made a careful study of this subject and finds that the patients that have symptoms for a long time have hearts that are smaller than normal, and that in the teleroentgenograms of such hearts, the angle between the lines "L" and "MR" is greater than the average normal. He also states that the long, narrow

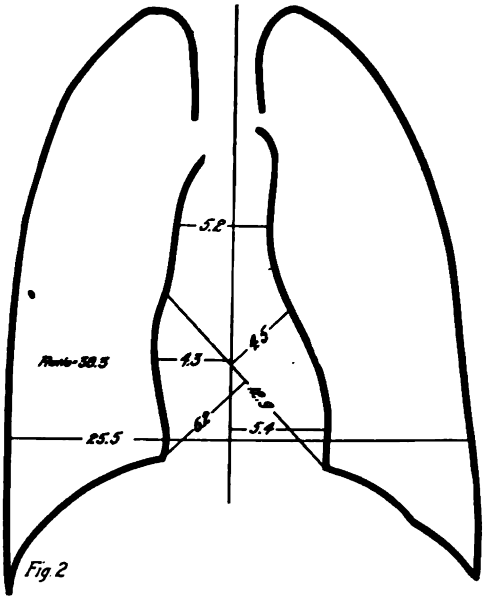


Fig. 2

Fig. 2. Hypoplastic Heart. O. P. D. 391673. P. H. Diphtheria, mumps and measles as a child. Has never used alcohol. Tobacco used in moderation. Denies venereal disease. No other important illnesses.

P. I. Has never had any cardiac symptoms but was rejected for the draft because the examining physician found some murmurs.

P. E. Weight 129½ pounds. Age thirty. Apex beat not visible. Impulse forceful and rate rapid as a result of the excitement resulting from examination. No supracardiac dullness. Systolic murmur heard at apex, at second right interspace and in the pulmonic area. Murmur loudest in the aortic area. A_2 sharp and clear; P_2 not accentuated. Second sound at apex clear and pure. Pulses equal and regular and of good volume and tension. Blood pressure 130/80.

"drop heart" is not predominant type, but that the structure may assume a great variety of shapes. It is well to keep in mind the fact that the small heart is thought to be of definite significance only in the patients that have symptoms, for a great many people possessing such small organs do not seem to suffer any great inconvenience therefrom. The effort syndrome is doubtless the resultant of numerous factors in a poorly developed body, the small heart constituting but one of the many.

PERICARDITIS

The diagnosis of pericarditis with or without effusion has long been one of the most difficult problems confronting the clinician and roentgenologist alike. Dr. George W. Holmes[9] has recently published an excellent account of the findings in the former condition, and through his kindness tracings from one of his cases (Figs. 3 and 4) are presented. According to his observations there is in pericardial effusion a change in the shape of the heart shadow with change in position, an obliteration of the normal curves

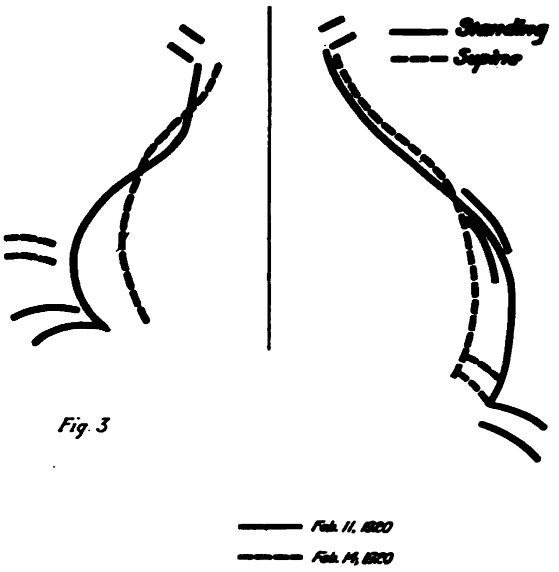


Fig. 3

Fig. 3. Pericarditis with Effusion. Case No. 24392. May 3, 1916 (morning). P. I. Had an attack three months ago characterized by pain in right side, productive cough, chills, fever, cold sweats, and palpitation brought on by slight exertion. Says she had fluid in chest but was not tapped. Dyspnea has been constant and increasing in severity since this attack. At times everything "looks black." Fainted four days ago. Unable to rest on left side. Cannot sleep. Too sick to answer questions fully.

P. E. Apex impulse diffuse and not forceful. Question of shifting with change of position. Sounds regular, rapid, and somewhat muffled. P_2 greater than A_2 and accentuated. "To and fro" friction rub in aortic area and well heard to right of apex. No murmurs made out. Both sounds heard distinctly at apex. A few moist râles and increased whispered voice below right scapula behind.

Operation: A needle was put into the pericardial sac in the 5th interspace 3 cm. to the left of the nipple line and directed upward and inward. After penetrating about 1½ inches through the chest well, 90 c.c. of thick, sticky, yellow fluid were removed. The pulse became fuller and slower and varied from 120–130. The dyspnea and cough subsided and the patient was much more comfortable.

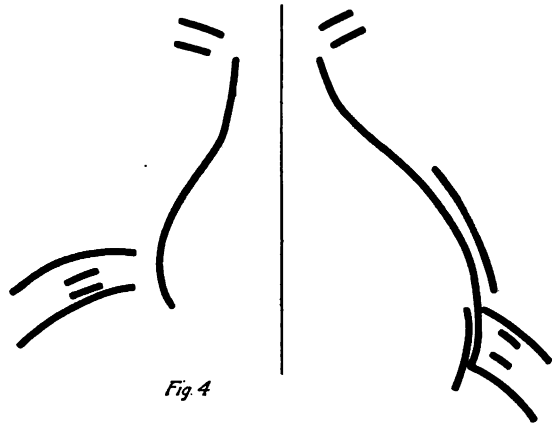


FIG. 4. Pericarditis with Effusion. 26 days after tapping. Question of adhesive pericarditis. Same case as Figure 3. Friction rub still present. Lung signs clearing up. Cardiac dullness much decreased in size. Some anemia. Patient still in bed. Pulse rises when she gets up. Movement of left border of heart seems limited during respiration. Pericardium is probably becoming adherent.

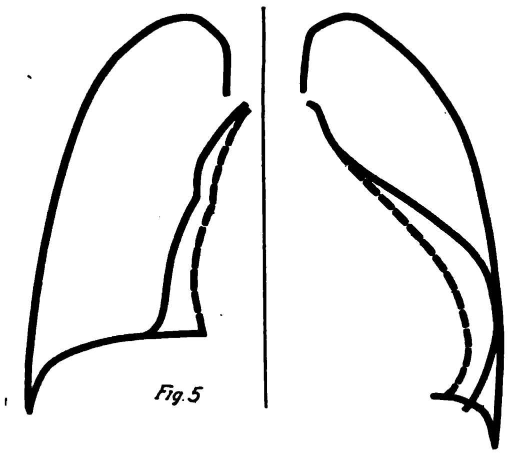


FIG. 5. Acute Dilatation of the Heart. Case No. 235074. Feb. 10, 1920. P. H. Pneumonia as a child. No scarlet fever, tonsillitis, rheumatic fever, or chorea.

P. I. Seven weeks ago she caught a cold and suffered from pain in the chest. After three days she had a cough, chilly sensations, a pain in the side and felt feverish. Was in bed with pneumonia for a month. Got up three weeks ago and has felt pain in right side with a cough ever since.

P. E. Patient is a white girl of thirteen weighing 90 pounds. She has lost seventeen pounds in eight weeks. There are signs of a small amount of fluid at the right base. Heart sounds regular, rapid and of good quality. P_2 greater than A_2 and Sl. accentuated. There is a blowing systolic murmur partly replacing the first sound which is snapping at the apex. Apex shifts in left lateral position. No thrill. Liver dullness extends 5 cm. below the costal margin.

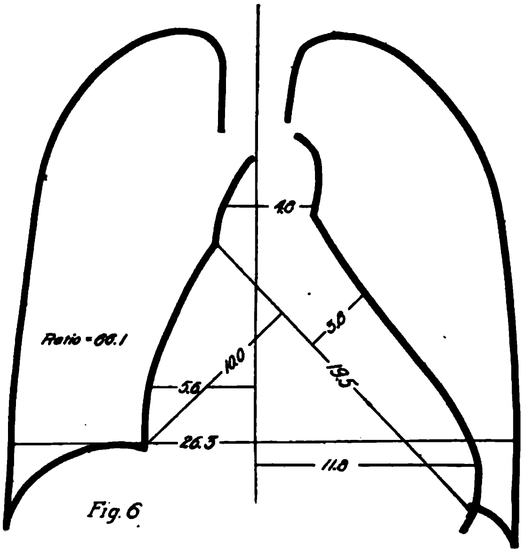
Feb. 15, 1920. Loud friction rub is heard all over the precordia. Loudest just to the right of the sternum in third interspace.

Feb. 24, 1920. Friction rub much diminished.

Feb. 28, 1920. Friction rub no longer heard.

of the cardiac outline and very faint or absent visible pulsation. Fig. 3 represents fluoroscopic tracings made with the patient supine and standing. This case was a longstanding one of tuberculous origin and apparently the pericardium had stretched sufficiently to show considerable change of shape with change of position and had produced the so-called water-bottle appearance. There is some question as to whether an acute effusion of sufficient size to cause tension in the pericardial sac would show this change of shape with change of position. The greatest difficulty in diagnosis arises as a result of the similarity between a pericardial effusion and an acutely dilated heart. They both show a similar shape, faint or absent visible pulsation, and an obliteration of the posterior mediastinal space. The change of shape with change of position does not occur in the case of the dilated heart, and where this change is actually observed a diagnosis of effusion may be made with a fair degree of certainty. Figure 4 represents a fluoroscopic tracing of the cardiac outlines after the disappearance of the effusion shown in Figure 3. The outlines of an acutely dilated heart are shown in Figure 5. The solid line represents the shape which the structure assumed following an attack of pneumonia. The dotted line represents the appearance three days later, when the dilatation had subsided. These drawings were traced from ordinary chest plates made with the same target plate distance. A large effusion would not disappear in three days, and it is because of this fact that the diagnosis was made. It is interesting to note that a friction rub was heard. This is, however, not an unusual finding in acute dilatation of the heart, although it is often interpreted as a sign of pericarditis.

Adhesive pericarditis is no more easily



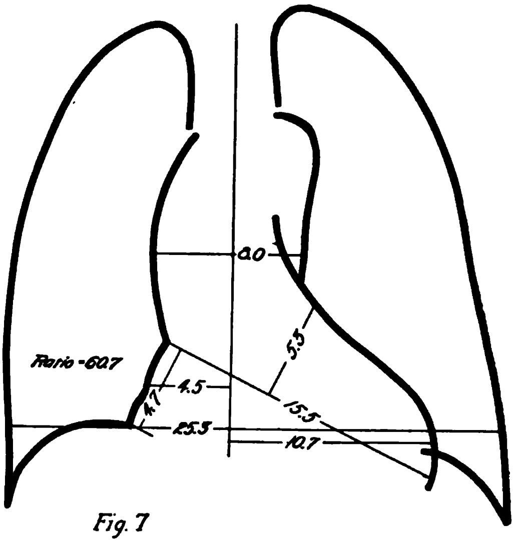


FIG. 6. Double Mitral Disease with Probable Aortic Involvement, Question of Adhesive Pericarditis. Case No. 231847.

P. H. Diphtheria as a child. Rheumatic fever thirteen times since the age of eight. Many bad sore throats. Chorea at age of eight. An attack of dyspnea lasting six weeks occurred six years ago.

P. I. Influenza nine months ago. Attack of rheumatic fever with severe precordial pain and pain in the lower abdomen of a sharp, cramp-like nature six months ago. Constant sharp pain in lower back and right hip began four months ago. Now has a fever, night sweats, and some precordial pain together with sharp pain in the lower abdomen.

P. E. White man. Age thirty-one. Weight 120 pounds. Purpuric rash on ankles. Heavy apex impulse in the fifth space. Sounds regular and of fair quality. Not rapid. P_2 gretaer than A_2. Blowing "to and fro" murmur over the precordia heard best in the third left interspace and transmitted to the axilla, neck and back. First sound slightly roughened at apex. Second sound replaced by murmur. Pulses corrigan in type. Question of thrill at the apex. Blood-pressure 120/40. Brachials negative. Liver edge 2 cm. below costal margin.

Laboratory Findings. R. B. C. 3,000,000. Hbg. 80%. Wassermann positive. Blood cultures show hemolytic streptococcus at four examinations.

Fluoroscopic Report. Practically no respiratory excursion of the left border of the heart.

Fig. 7. Arteriosclerosis. O. P. D. 392975. P. I. Complains of diplopia which began about eight months ago. Growing steadily worse. Also has supra-orbital headaches and "muscular rheumatism." Troubled with nocturia, polyuria and eneuresis.

P. E. White man. Age seventy-two. Weight not obtained. Left eye turned in. Pupils irregular and very small. Fixed to light but react to distance. Palate reflexes absent. Heart sounds regular and of fair quality. Systolic murmur at the apex and slight systolic whiff at the aortic area. A_2 greater than P_2 and accentuated. Blood-pressure 174/112. Left knee swollen and somewhat tender. Slight numbness of both legs. Marked Romberg. Knee jerks absent. Falls when walking around the house. *X*-ray of left knee shows a narrowed joint space and thickened soft parts. The appearance is that of a chronic synovitis. Clinical diagnosis of tabes was made.

diagnosed than is the type accompanied by effusion. The frequency with which the diagnosis is missed is emphasized by Lyter[10], who describes the findings in thirty autopsied cases. He calls attention to the fact that the left border of the heart should normally move three cm. during deep respiration and should shift three cm. when the patient turns from the right lateral to the left lateral position. The fluoroscopic method of noting the respiratory excursion has already been described. Seven-foot plates made with the patient lying first on one side, and then on the other will demonstrate the lateral shift so that it can be measured. When adhesions occur between the pericardium and the pleura, these two shifts are likely to be diminished or completely done away with. Unfortunately adhesions do not form outside of the pericardium in all cases of pericarditis. When a dense mass of fibrous material forms between the heart and pericardium, the left border often becomes a straight

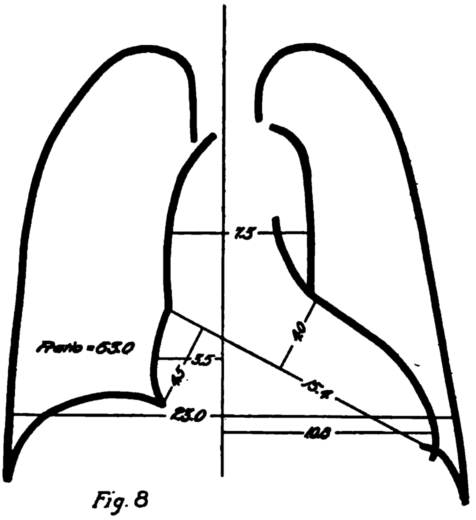


FIG. 8. Senile Heart. O. P. D. 325755. P. H. Negative except for pain in the back beginning one and a half years ago. Never any nocturia. Cta. ceased fourteen years ago.

P. I. Now complains of constant dizziness and hot flashes. Occasional attacks of palpitation. Considerable pain at times over the eyes and in the back. Intermittent edema of the ankles.

P. E. Patient is a white woman of sixty who weighs 190 pounds. Pulse regular. Rate 80. A_2 accentuated. No murmurs. Blood-pressure 220/104.

Laboratory Tests. Wassermann negative. Urine negative.

line and the cardiac shadow assumes the triangular shape which has been described as a sign of adhesive pericarditis. No pulsations or chamber curves are made out, because figuratively speaking the heart is held in a vice of fibrous tissue. Figure 6 represents such a case in which an endocarditis has gone on to a pancarditis with extensive involvement of the pericardium. Needless to say, all of the cases diagnosed clinically as pericarditis do not show definite roentgen ray signs, but these signs when they do occur are perhaps as definite as any elicited in this malady.

MYOCARDITIS

Myocarditis, that is, a disease of the heart muscle, may result from a great variety of causes, but usually produces definite cardiac enlargement in time. This enlargement is often limited to the ventricles and so produces an increase in the long diameter with some prominence of the curve of the left ventricle. The curves representing the left auricular appendage and pulmonary artery are not, as a rule, distinguishable. Cases illustrating two fairly common classes of chronic myocarditis are cited. Figures 7 and 8 are taken from seven-foot plates of patients possessing senile hearts. Perhaps "cardiosclerosis" is a better term than "senile hearts", for these patients are usually rather aged and show definite arteriosclerosis. They may or may not have a hypertension. Definite symptoms are present and some clini-

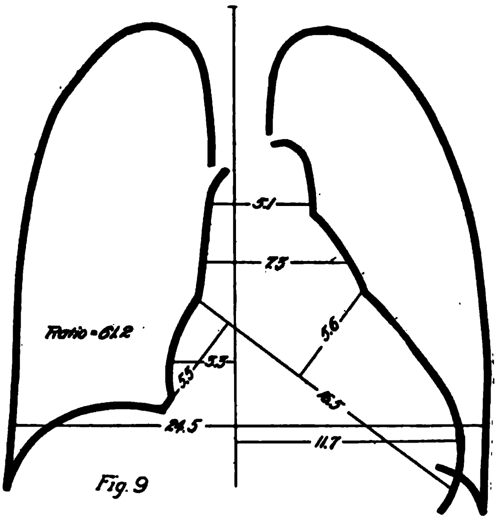


FIG. 9. Hyperthyroidism. W. M. 11454. Nov. 2, 1916. P. H. Scarlet fever at three. Diphtheria at six. Attacks of tonsillitis almost every year.

P. I. Slight swelling of the neck noticed eleven years ago. Tumor reached present size in four months at end of which time patient noticed that her hands trembled. Exopthalmos appeared two years later. Began to notice rapid, powerful heart action, dyspnea on exertion and excessive moisture of palms about one year ago.

P. E. White woman of thirty-six weighing 139 pounds. Appears to have lost weight. Marked exopthalmos and loss of power of convergence. Thyroid very prominent. Right side more so than left. Definite pulsation. Loud bruit heard over gland. Heart enlarged. P_2 accentuated, louder than A_2 and doubled. Loud blowing systolic murmur at apex transmitted to the axilla and upwards. No edema. Coarse and fine tremor of the hands. Blood-pressure 150/84.

Nov. 23, 1916. Right hemithyroidectomy was done.

Metabolism Reports.

Nov. 3, 1916	+17
Nov. 7, 1916	+57
Nov. 14, 1916	+41
Dec. 16, 1916	+39

cians state that the victim has a "dying myocardium" as a result of a poor blood supply to the cardiac muscle. The aortic arch is usually tortuous and wider than normal, and the pulsations of the ventricles often appear to be feeble. Hearts of this type are likely after a time, to become very long and narrow, and resemble a beef tongue in appearance, the apex corresponding to the tip of the tongue. No evidence of the left auricular appendage can be made out and the whole organ appears to assume a horizontal position in the chest. No roentgenologist is justified in diagnosing this condition from the roentgen ray findings alone, but when such an appearance is encountered in a person past middle age, who shows arteriosclerosis and is complaining of vertigo, dyspnea, palpitation, and perhaps angina, the diagnosis cannot be far wrong. It is a rather interesting fact that the patient whose heart is shown in Figure 7 was said to have tabes. A number of tabetics were examined and almost without exception they showed hearts of this type. They were examined with the hope that they would show definite signs of syphilitic aortitis. It has often been stated that syphilis is an etiological factor in arteriosclerosis and these findings would seem to substantiate this statement because some of the patients examined had not reached the age of forty.

Chronic hyperthyroidism is usually accompanied by a myocarditis which produces definite cardiac enlargement. Such a case is illustrated in Figure 9. Cardiac enlargement was found by the author only in patients who had had symptoms of hyperthyroidism for a number of years. The prominent curve of the left ventricle and the increased length are well shown in the case cited. Many cases show the prominence in the region of the pulmonary artery as shown here. This may possibly represent the border of an enlarged thymus gland. Such an enlarged gland was demonstrated in one such case at autopsy. When the heart has once become affected in these cases, it is in no way benefited by a reduction of the thyroid secretion except in so far as a reduction of the pulse rate may serve to reduce the load carried, and patients may continue to have dyspnea on exertion and some tachycardia after the basal metabolism is reduced to normal, as a result of a myocarditis. The roentgenologist is fairly safe in making this diagnosis in old cases of hyperthyroidism that show definite ventricular enlargement.

VALVULAR DISEASES

A case of acute endocarditis is rarely sent to the roentgen ray laboratory because absolute rest in bed is one of the essentials of treatment and the heart is not so likely to show a characteristic shape during the febrile stage of the disease. However, when the infection subsides and the valve cusps are retracted or stenosed as a result of the formation of scar tissue, the valves begin to leak. This increases the cardiac load and the various chambers become dilated or hypertrophy in an effort to take care of the added work. It is at this stage that the roentgen ray examination should be attempted.

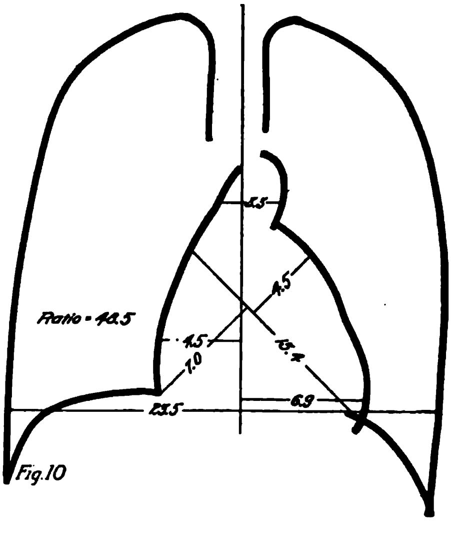
Generally speaking, the valves of the heart are open to two lines of attack. Syphilis beginning in the aorta is likely to move downward and involve the aortic valve, but extends no further along the endocardium. Rheumatic infections, on the other hand, usually begin at the mitral valve and may extend upward to the aortic valve but do not involve the aorta. Other valves may at times be affected, but such lesions are rarely correctly diagnosed before death. An occasional case of rheumatic involvement of the aortic valve alone is encountered now and then.

When the mitral valve fails it may show stenosis or a combination of stenosis and insufficiency. Autopsy findings at the Massachusetts General Hospital seem to indicate that pure insufficiency is a rather rare lesion of the mitral valve. No matter what the lesion may be, a failure of the efficiency of the valve disturbs the mechanical balance of the heart, and blood is either held back or is allowed to regurgitate back into the left auricle. This causes dilatation of that structure and a prominent of the left auricular appendage curve in the roentgenogram. Pulmonary congestion results, and an extra load is thereby thrown upon the right ventricle which in turn passes it back to the right auricle. With an incompetent valve much blood from the dilated left auricle flows into the left ventricle during diastole and causes some increase in the size of that structure. Since the right ventricle pumps blood into the lungs through the pulmonary artery it is also likely to show some dilatation and this helps to accentuate the prominence of the curve of the left auricular appendage, since the shadows of the two structures adjoin one another. The extra load on the right auricle usually causes a marked prominence of the right border of the heart. The enlargement of the right ventricle causes an increase in both the transverse diameter and the distance across the auricles. From this brief description it is evident that the changes produced tend to increase the dimension "B" (equals "X" plus "Y"). When the mitral valve is incompetent "L" may also show some increase as a result of a certain amount of enlargement of the left ventricle; but this is, as a rule, not a striking change.

In examining cases of chronic mitral disease fluoroscopically, it is not at all uncommon to find the lower posterior mediastinal space entirely obliterated by enlarged auricles which extend backward until they come in actual contact with the spinal column. Figure 10 illustrates the findings in a case diagnosed clinically as pure mitral stenosis, whereas Figures 11 and 12 represent double mitral disease. It is interesting to note that in Figure 10 the transverse diameter of the heart does not definitely exceed 50 per cent of the internal diameter of the chest, although the heart has a typical "mitral shape." This is, no doubt, due to the absence of enlargement of the left ventricle. Groedel calls attention to the fact that the cardiac shadow may be relatively small in mitral stenosis, and this is probably the only type of chronic organic heart disease in which the cardiothoracic ratio does not always indicate enlargement. Figure 11 shows a marked prominence of the curve of the right auricle. Figure 12 shows this same prominence combined with an enlargement of the left auricle sufficiently great to obliterate completely the angle normally seen between the descending aorta and the remainder of the left border of the heart. These three drawings illustrate the fact that in mitral disease the dimension "B" approaches the dimension "L" as a limit and as a result the cardiac shadow tends to assume a circular shape. No other cardiac disturbance produces the same series of changes, and when the roentgenologist observes such configuration he is justified in suggesting the diagnosis of mitral disease which should, of course, be checked up by a physical examination.

If the rheumatic infection extends to the aortic valve and a double valve lesion results, the left ventricle of necessity takes up a larger share of the increased load and becomes definitely enlarged. The apex may as a result descend to the level of the sixth interspace in front and on the long diameter is definitely increased. It is only necessary to add to the mitral picture an increased length and a prominence of the curve of the left ventricle to produce the appearance of double valvular disease, as illustrated in Figures 13 and 14. The curve of the left ventricle becomes relatively more and more prominent as we pass from mitral stenosis through double mitral disease to aortic regurgitation.

Pure aortic stenosis is an extremely rare condition and is diagnosed by good clinicians only after much deliberation. The case illustrated in Figure 15 was so diagnosed. It is quite possible that myocarditis is responsible for some of the changes seen. Two points of interest may be noted. The enlargement is limited to the ventricles, chiefly the left, since the distance "B" extending across the right ventricle is not increased, and the aortic



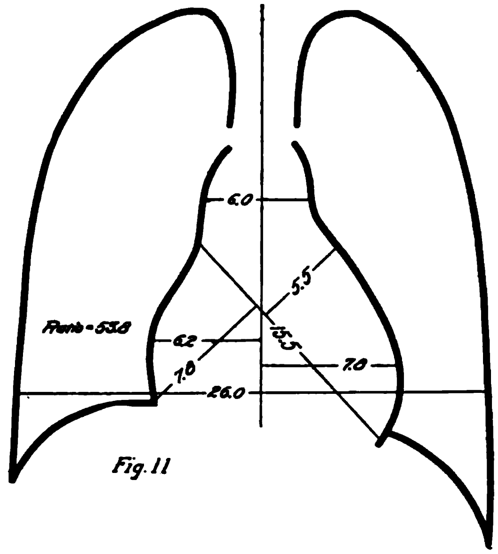


FIG. 10. Mitral Stenosis. Case No. 231751. P. H. No history of children's diseases. For several years has been troubled with attacks of dyspnea, cyanosis, and a choking sensation after exertion. No productive cough or edema. Some attacks accompanied by knife-like precordial pain and a dry cough.

P. I. Balance of past year spent in bed. Attacks characterized by dyspnea, dry cough, cyanosis, palpitation, and sharp precordial pain still occur.

P. E. White girl. Weight, 117 pounds. Sounds regular and rapid. P_2 greater than A_2 and accentuated. Pre-systolic roll at apex. First sound loud and sharp. Slight systolic and loud rough diastolic murmur at apex transmitted to axilla. Slight thrill in fifth interspace. Blood-pressure 110/65.

Laboratory Findings. Renal function 50 per cent. Wassermann negative.

FIG. 11. Mitral Disease (probably double). Case No. 232110. P. H. In bed with rheumatic fever one month, four years ago. Scarlet fever followed by rheumatic pain which kept him in bed ten weeks, seven months ago. Venereal denied. No tobacco or alcohol.

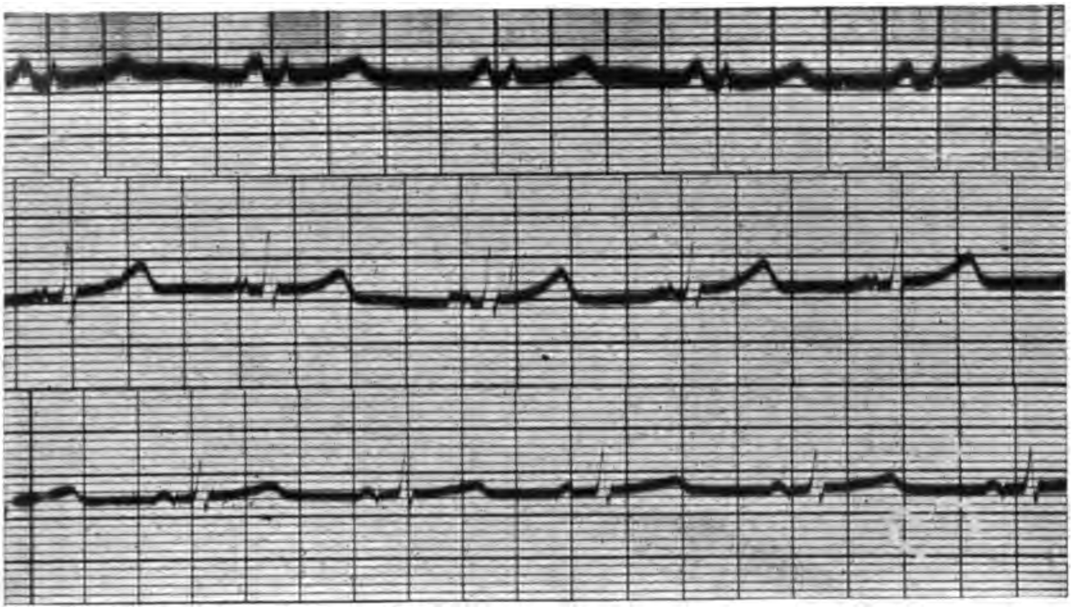
P. I. Turned down by draft board about one year ago. Dyspnea and palpitation followed attack of scarlet fever and rheumatism seven months ago. No edema. Chief complaint at present is dyspnea, weakness and palpitation following exertion.

P. E. White man. Age twenty-one. Weight 138. Mucous membrane cyanotic. Tonsils red, large and ragged. Venous pulsations seen in neck. Cervical glands palpable. Heart impulse heaving and diffuse, and seen in 4th interspace. Sounds regular and slightly rapid. First sound replaced by systolic murmur, transmitted to axilla, precordia and back. No definite thrill. P_2 greater than A_2. Reduplicated and accentuated. Arterial walls not palpable. Brachials not tortuous. Blood-pressure 140/70. Knee jerks present and equal.

Laboratory Findings: Urine negative. Wassermann negative.

arch is normal in size and shape. The normal arch makes the presence of syphilitic aortitis, cardio-renal disease with hypertension, or arch sclerosis rather unlikely, and it is therefore necessary to explain the ventricular enlargement as resulting from a rheumatic infection of the aortic valve, a myocarditis, or an aortic stenosis. It is very unlikely that any roentgenologist would be so rash as to hazard the correct diagnosis on the basis of the roentgen appearance alone.

Aortic valve involvement is in a large majority of adult cases due to syphilis and its onset is likely to be preceded by a syphilitic aortitis of the ascending aorta. Figure 16 illustrates an advanced case of this type. There is a marked increase in the width of the aortic arch and a prominence in the lower part of the ascending portion which probably represents a localized dilatation. The heart is very long and lies transversely in the chest as a result of a high diaphragm. The auricles are not enlarged, but the curve of the left ventricle is very prominent. The distance across the base "B" is not outside normal limits, and it may be inferred that the left ventricle is enlarged much more than the right. Left ventricular preponderance is often present in cases of aortic regurgitation.



GRAPH. I. Illustrating Figure 10. Broad notched "P" wave of the type often seen in mitral stenosis.

CARDIO-RENAL DISEASE

A patient with damaged kidneys who has maintained a high blood-pressure for a long time must of necessity possess a large hypertrophied heart if he is to keep his bodily machine operating. If the hypertrophy is not sufficient to meet the heavy demands of a high blood-pressure, he suffers from various cardiac symptoms. The hypertrophy is usually pretty well distributed between the two ventricles, and as a result such hearts become enormous in size. Figures 17 and 18 show fairly typical cases. The aortic knobs are prominent, perhaps as a result of arteriosclerosis, which is often present in cardiorenal disease. Although the curves representing the auricles are not at all prominent, the distance "B" is outside normal limits and this seems to indicate the presence of a definite hypertrophy of the right ventricle. The increased length of the heart and the prominence of the curve of the left ventricle point toward hypertrophy of that structure. The roentgenologist is not always justified in describing an increase in cardiac size as due to hypertrophy rather than dilatation, but in these cases the vigorous pulsations observed fluoroscopically seem to point in that direction. Early cardio-renal cases do not show such pronounced changes and may be easily confused with other conditions causing ventricular enlargement.

DISEASES INVOLVING THE GREAT VESSELS

This subject was more fully covered in a previous article[11], but this survey of diseases of the heart would hardly be complete without some reference to it. Many of the drawings shown here were used in the previous article. It is probably true that a large number of cardiac cases are sent to the roentgenologist because the clinician is afraid that he may be overlooking a syphilitic aortitis or to check up his diagnosis of that condition. The diagnosis of aortitis should be made with the greatest caution in cases showing widened shadows of the great vessels. Arteriosclerosis, hypertension, chronic mitral disease, a high diaphragm, or an enlarged pulmonary artery may produce widened shadows of the great vessels.

Figure 19 illustrates a typical wide, tortuous aortic arch of the type seen in advanced arteriosclerosis. The widening is apparently due to the fact that the descending aorta swings to the left. The aortic knob

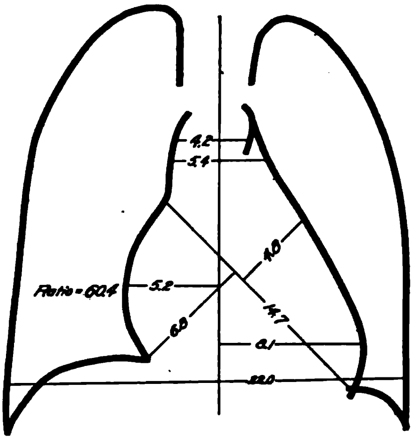


Fig. 12

Fig. 12. Mitral Disease and Chorea. O. P. D. 244944. June 13, 1914. P. H. Negative except for scarlet fever five months previously.

P. I. Has complained of tenderness on being touched for several weeks. Is very nervous and rather weak.

P. E. Patient is a white girl seven years of age. Tonsils are ragged and protrude. Heart is swollen. Heart is not enlarged. Sounds regular and of good quality. No murmurs heard. No swollen or tender joints. Considerable choreiform movement.

Mar. 20, 1920. P. E. Heaving apex impulse in the 5th space 10 cm. to the left of the midsternum. Loud systolic murmur at the apex partly masking the 1st sound. Pulmonic 2nd sound very loud and reduplicated at the apex. Slight diastolic rumble when the patient lies down.

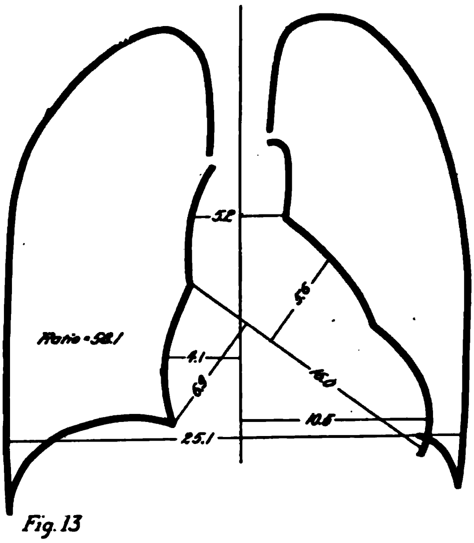


Fig. 13

Fig. 13. Double Mitral Disease and Aortic Regurgitation. O. P. D. 392730. P. H. Has had attacks of rheumatic fever and sore throats during the past year. No other serious illnesses.

P. I. Comes in complaining of pain in all of the joints of the body which has been worse during the past three months. Dyspneic after climbing a flight of stairs. Occasional edema of the ankles.

P. E. The patient is a white man of twenty-four who weighs 140 pounds. Heart sounds regular. There is a loud blowing systolic murmur heard all over the precordia with a maximum intensity at the apex. The murmur is transmitted to the axilla. P_2 is accentuated. There is an early diastolic murmur heard just to the left of the sternum in the 3rd interspace. The apex is felt in the 6th space. The apex impulse is felt in the 6th space.

Laboratory Tests. Wassermann negative.

is usually prominent in arch sclerosis even though it be partially obliterated by the shadow of the descending portion of the vessel. If the patient be rotated to the left in the fluoroscope until the shadow of the ascending aorta overlies that of the descending aorta, the transverse dimension of the resultant shadow should not seem too large. It is often possible to take plates in the left oblique position which show the entire ascending, transverse, and descending thoracic aorta. The heart illustrated in Figure 19 might be said to be a sequela of cardio-renal disease, but the nephritis is probably arteriosclerotic in origin, and the sclerosis of the arch may have preceded the nephritis.

Arteriorsclerosis is to be expected in the aged; but younger people sometimes have it. A case of arteriosclerosis with hypertension and a wide, tortuous, aortic arch is shown in a woman of thirty-nine in Figure 20. A girl in the early twenties with a similar condition was also observed. These cases of precocious arteriosclerosis are not so uncommon as one might suspect, and it is just such a case that is most likely to be branded as syphilitic when a wide arch is discovered.

The obese patient almost always shows a wide area of supracardiac dullness, and in many cases this is due to the high position of the diaphragm. Figure 21 shows three wide arches observed in obese persons and also the widening of the arch resulting from forced expiration in an individual of average size. The position of the diaphragm should be carefully observed in aortitis suspects.

The effect of chronic mitral disease on

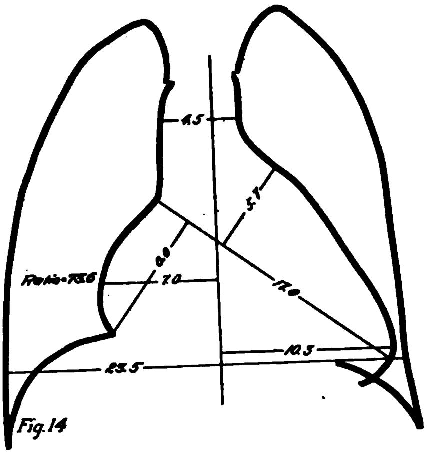


Fig. 14

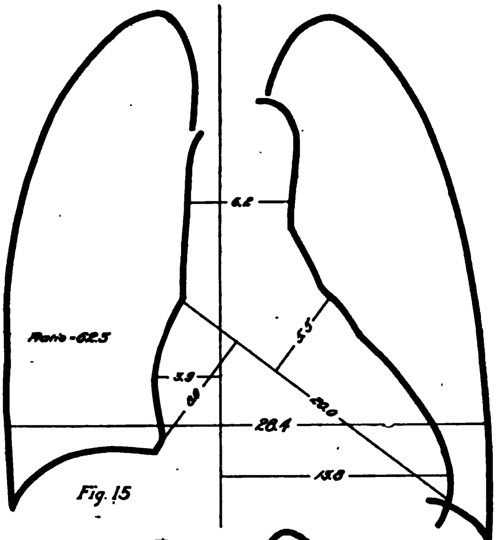


Fig. 15

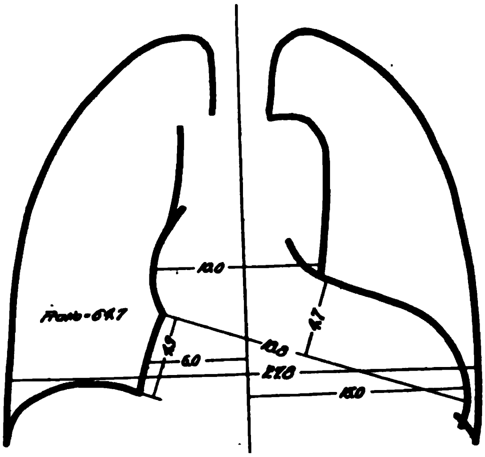


Fig. 16

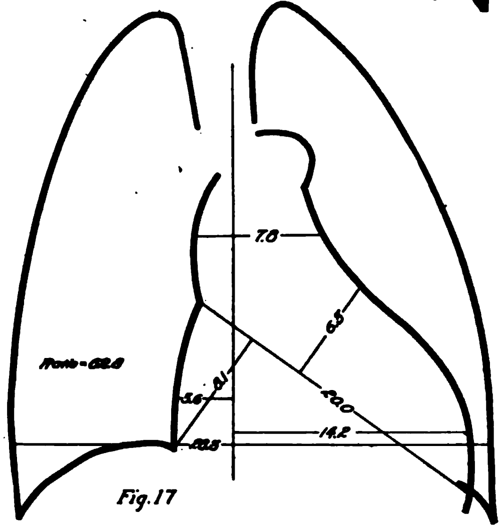


Fig. 17

FIG. 14. Double Mitral Disease and Aortic Regurgitation. P. H. In bed with polyarticular rheumatism eleven years ago. Similar attacks since. Influenza and pneumonia nine months ago.

P. I. Pain appeared in precordia and right shoulder two years ago. Became dyspneic on exertion eleven months ago after an attack of influenza. A severe rheumatic attack occurred one month ago.

P. E. Apex impulse in 5th space. Sounds of good quality. Occasional premature beat. P_2 greater than A_2 and much accentuated. Loud blowing systolic and diastolic at the apex. "To and fro" murmur at the base. Arterial walls palpable. Thrill at the apex. Blood-pressure 126/60. Wassermann negative. Age, twenty-six. Weight 104 pounds.

FIG. 15. Aortic Stenosis. Case No. 230864. P. H. A painter for thirty years. Lead colic sixteen years ago. Gonorrhea at twenty. Syphilis denied. Much alcohol up until ten years ago.

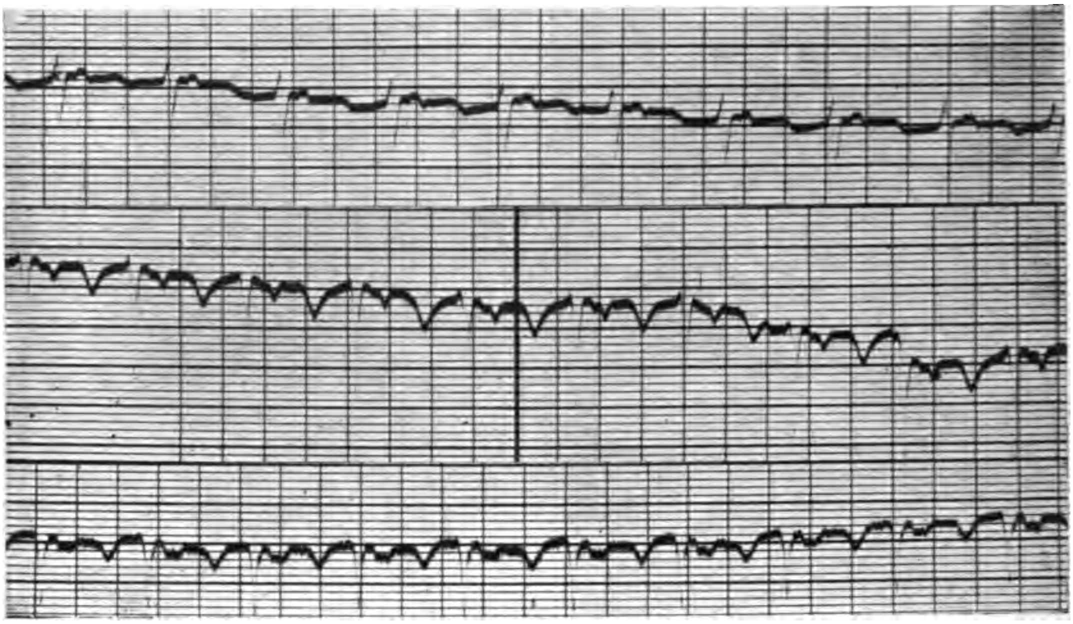
P. I. Three years' duration beginning with dyspnea and palpitation. Aching pains in legs began eighteen months ago, worse in evening. Cough began five months ago. Edema of ankles for past three weeks with cyanosis and dyspnea on exertion.

P. E. Age fifty-eight. Weight 144 pounds. Brachials sclerosed. Harsh blowing systolic murmur at base, heard best in aortic area and transmitted to neck. Double murmur at apex which disappeared after rest in bed. Systolic thrill in aortic area. Blood-pressure 115/90. Wassermann negative. Electrocardiogram shows left ventricular preponderance and premature ventricular contractions.

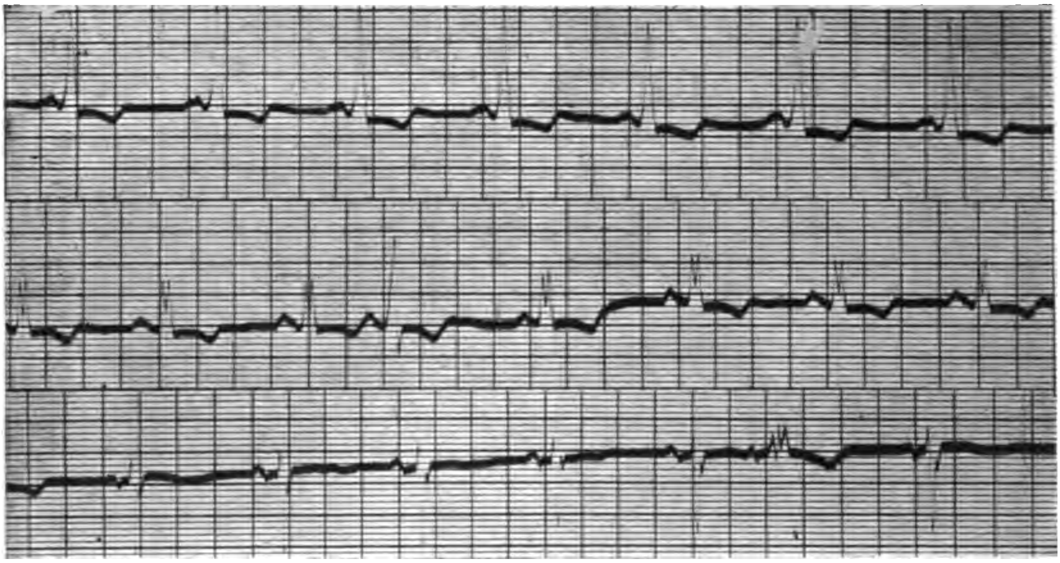
FIG. 16. Syphilitic Aortitis and Aortic Regurgitation. O. P. D. 404570. P. H. Has had pneumonia twice. Gonorrhea twenty-five years ago. Married thirty years. Wife has never been pregnant.

P. I. Has suffered from epigastric distress, dyspnea, and palpitation on exertion for about eight months. No edema.

P. E. Negro man. Age sixty-one. Weight 185 pounds. Blood-pressure 200/80. Knee jerks absent. Pupils sluggish. Brachial arteries sclerosed and tortuous. Corrigan pulse. Double murmur in the aortic area. Diastolic murmur to the left of the



GRAPH II. Illustrating Figure 14. Tachycardia. B road notched "P" waves in all leads.



GRAPH III. Illustrating Figure 15. Left ventricular preponderance. Right ventricular premature contractions. Aberrant ventricular contractions. Invert "T" wave. "P" wave broad and notched in leads I and II.

sternum. A_2 absent. Pistol shot sound in the groin. Visible pulsations in the neck.

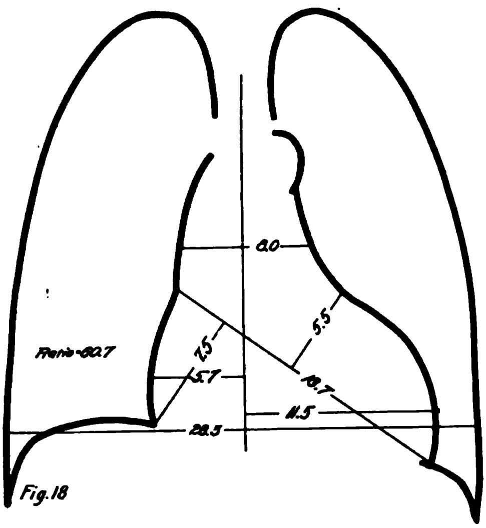
Laboratory Findings. Urine not definitely abnormal at one examination.

FIG. 17. Cardio-Renal Disease. Case No. 231934. P. H. Diphtheria at twenty-five. Tonsillitis at same time. Syphilis at age of twenty. Does not drink steadily but goes on alcoholic sprees.

P. I. Nocturia began one year ago; has gotten progressively worse. Severe frontal morning headaches began seven months ago. Attacks of dyspnea during past seven months. Blurring of vision and spots before the eyes for past three months. Dizzy vomiting spells for past two months. Cramps in legs recently.

P. E. White man. Age forty-nine. Weight 150 pounds. Sounds regular and rapid. P_2 greater than A_2. Both accentuated. Soft systolic murmur over precordia heard best in the 4th left interspace. Pulses equal and of high tension. Arterial walls palpable. Blood-pressure 210/140. Brachials tortuous. Fundi show albuminuric retinitis.

Laboratory Findings. Renal function 10 per cent. Wassermann negative.



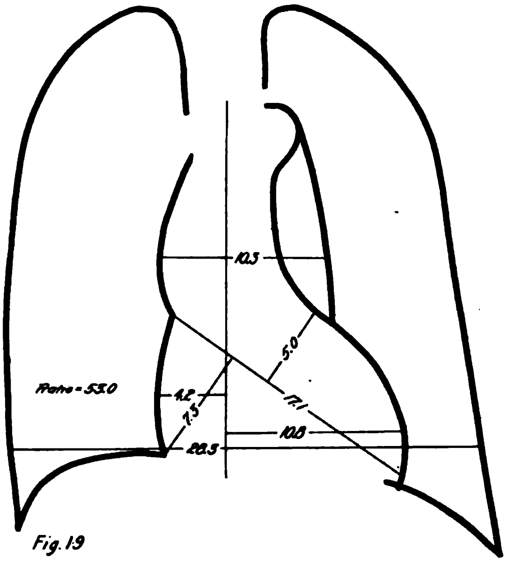


FIG. 18. Cardio-Renal Disease. Case No. 233130. P. H. No diseases except scarlet fever in childhood. Always a heavy meat-eater. Used much alcohol up until two years ago. A heavy smoker.

P. I. Began to complain of dyspnea and a "lazy" feeling about three years ago. Has been in the hospital twice before because of worn out feeling. Orthopnea became noticeable two weeks ago and was accompanied by nocturia and edema of the ankles, lower legs, and thighs. No precordial pain at any time.

P. E. White man fifty-two years old, weighing 196 pounds. Jan., 1917. Sounds regular and of good quality. Rate normal. Soft systolic at the apex. Second sounds accentuated. Liver edge felt 2 cm. below the costal margin. Electrocardiogram showed left ventricular preponderance. Wassermann negative. Renal function 30 per cent. Urine showed a Sp. Gr. of 1020-24, albumin V. S. T. to S. T., and many hyaline casts. Blood-pressure 180/110.

May, 1919. P_2 equals A_2. Shrill high pitched murmur in the mitral area. No thrill. Brachials tortuous. Blood-pressure 210/140 to 230/140. Renal function 20 per cent to 25 per cent. Urine showed hyaline and granular casts and a Sp. Gr. of 1012 to 1020.

Oct., 1919. Second sounds accentuated. Blowing musical systolic murmur at the apex transmitted to the axilla. Radial arteries sclerotic and beaded. Blood-pressure 220/150. Râles in bases of lungs. Edema of angles and thighs. Fundi showed sclerosed and tortuous arteries and small sclerotic plaques. Urine shows a Sp. Gr. of 1010-14, a T. to V. S. T. of albumin and hyaline and granular casts. R. F. 25 per cent. Hbg. 70 per cent.

FIG. 19. Arteriosclerosis with Nephritis. Case No. 232022. P. H. Scarlet fever in childhood. Sick several months twenty years ago with nausea, diarrhea, vomiting and abdominal pain. "Grippe" four years ago. Generalized edema with headache, blurring of vision and delirium three years ago. A "shock" occurred one year ago. Unconscious for twenty-four hours. Some weakness in left arm and leg since. Venereal denied.

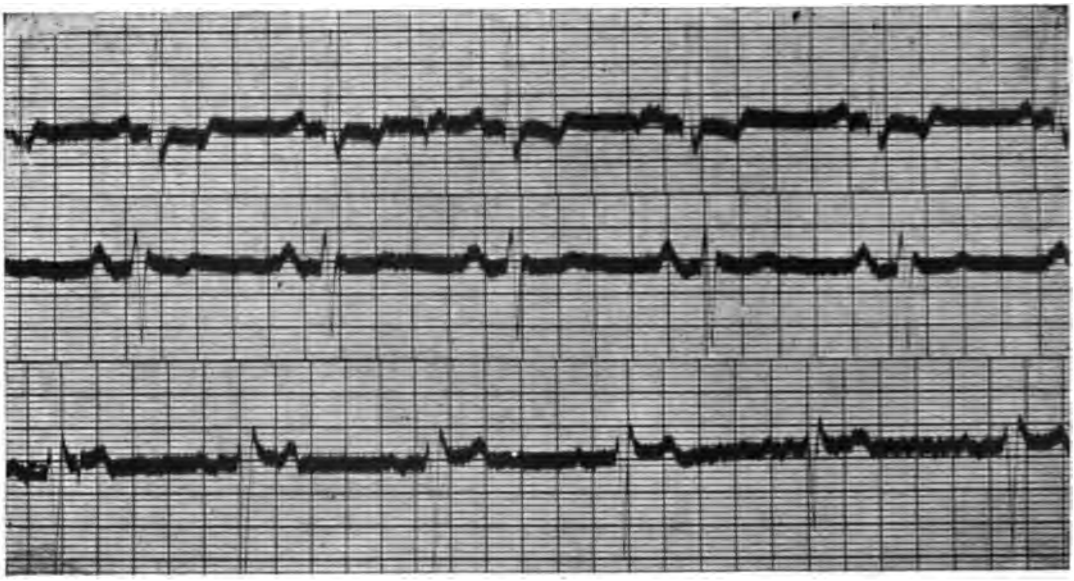
P. I. Feels weak and tired. Still has weakness of left arm and leg. Has attacks of dizzy sensations accompanied by vomiting, a feeling pressure in the head, and a general numb feeling.

P. E. White man. Age sixty-four. Weight 175 pounds. Pupils irregular. Cardiac impulse seen and felt in the 6th space. No thrills. Sounds regular and of fair quality but rapid. A_2 greater than P_2 and accentuated. No murmurs. Arterial walls palpable, brachials not tortuous. Blood-pressure 208/120. Knee jerks normal.

Laboratory Findings. Urine shows a trace of albumin, a Sp. Gr. of 1020 to 1023 and a frequent hyaline and granular cast at two examinations. R. F. 12 per cent. Wassermann negative.

the contour of the left border of the cardiac shadow has been discussed under the subject of "Valvular Disease." In Figure 12, the supracardiac dullness is shown definitely increased as a result of dilatation of the pulmonary artery and left auricular appendage. The clinician is very familiar with the increase in percussion dullness to the left of the sternum with the enlargement of the left auricle. Such cases present a fairly typical cardiac shadow and are not likely to be confused with aortitis.

The increased width of the supracardiac shadow accompanying chronic hypertension is well brought out in Figures 17 and 18. Smith and Kilgore[12] have called attention to a series of such arches in cases of cardio-



GRAPH IV. Illustrating Figure 18.

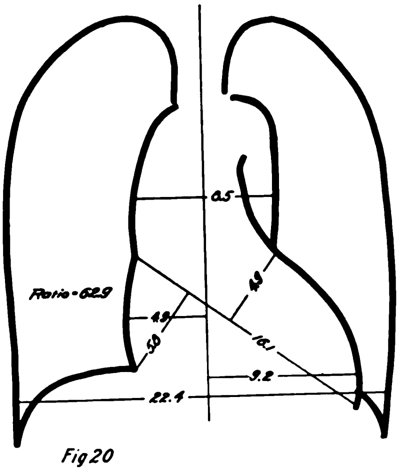


FIG. 20. Precocious Arteriosclerosis with Hypertension. Case No. 233568. P. H. No rheumatic history. No miscarriages. Venereal denied. "Tubes and ovaries" removed eleven years ago for pelvic abscess.

P. I. Weak and tired and subject to "hot flashes" and "cold sweats" since the age of eighteen. Dyspnea began three years ago. About two years ago she began to have palpitation and severe headaches accompanied at times by vomiting, dizziness, staggering, stars before the eyes and on two occasions everything turned black before her eyes. During the past year the above symptoms have been less but there has been some edema of the ankles and a numb feeling in the right leg and arm at intervals. No nocturia or other urinary symptoms.

P. E. Patient is a pale white woman, age thirty-nine, weighing 112 pounds. Marked venous pulsation in neck. Sounds regular and rapid and of good quality. A_2 is greater than P_2 and much accentuated. Reduplicated 1st sound and a systolic murmur at the apex transmitted to the axilla. Systolic murmur in the aortic area not transmitted. Very questionable thrills observed at the apex and at the aortic area. No presystolic murmur. Arterial walls palpable. Brachials tortuous. Blood-pressure was 270/190 six months ago and is 210/140 now.

Laboratory Findings. Urine shows nothing abnormal except S. P. T. of albumin and a rare white cell at numerous examinations. No fixation of gravity or retention of chlorides. Renal function 60 per cent. Non-protein nitrogen 35.9 mgs. per 100 c.c. of blood. Wassermann negative twice.

renal disease with hypertension, in which no evidence of syphilitic infection could be found. It has been claimed that the widening is due to a dilatation of the aorta resulting from the long continued high blood pressure. Some think that arteriosclerosis is also a factor. No matter what the etiology may be, it is a proven fact that the transverse dimension of the great vessels in such cases may measure 7, 8, or even 9 cm.

A dilatation of the pulmonary artery is only met with occasionally, but when it occurs, the appearance is very typical and produces a definite widening of the shadow of the great vessels resulting from a sharply defined prominence in the region of the pul-

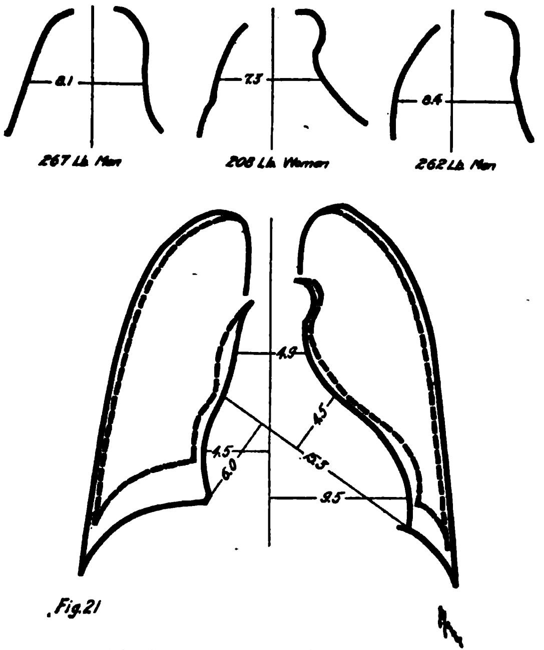


FIG. 21. Widening of the Shadow of the Great Vessels Due to a High Diaphragm. The three upper tracings represent the size and shape of the great vessels in patients weighing over 200 pounds. In each case there was a high diaphragm probably due to a large amount of abdominal fat. These sketches are traced from the seven-foot plates. In well built individuals weighing over 200 pounds and possessing a normally placed diaphragm the great vessels rarely measure over 6 cm. in width.

The large drawing represents the shape and size of the heart, great vessels, and thoracic cavity of a well built man thirty-nine years of age and weighing 142 pounds. The solid outline was made from a seven-foot plate taken during normal breathing while the broken outline was traced from a seven-foot plate of the same patient during forced expiration. This man was a recently discharged soldier who had been leading an active life and he had a good diaphragmatic excursion. During expiration the diaphragm rises and the chest walls are drawn in. The heart is forced upwards but apparently the upper portion of the aortic arch remains fixed. As a result the heart and great vessels are compressed and a widening of their transverse diameters results.

This patient came in complaining of a feeling of fullness in the chest which was worse after meals and had been present for about a year. There were no other symptoms. On auscultation there was a double murmur in both the aortic and mitral areas and A_2 was sharp. The pulse pressure was a little higher than normal. There was no rheumatic or syphilitic history. The electrocardiograph showed nothing abnormal. He was thought to have an early involvement of both the aortic and the mitral valves of rheumatic origin.

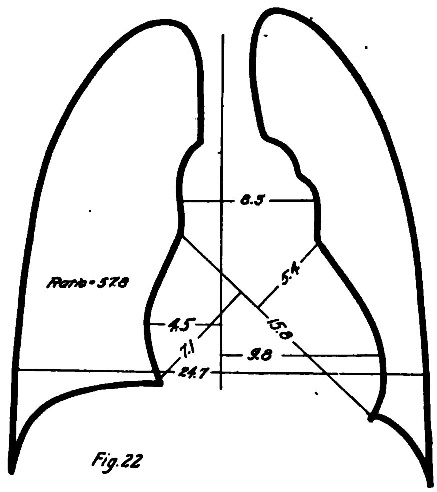


FIG. 22. Dilated Pulmonary Artery. Case No. 145038. P. H. Croupous pneumonia at twelve. Typhoid and diphtheria at thirteen. Question of bronchopneumonia at twenty-five. No rheumatic history. Question of chancroid eight months ago. In the hospital with a "cold" for two weeks about four months ago. Has been working but never "up to snuff." Some precordial pain and dyspnea for past two years.

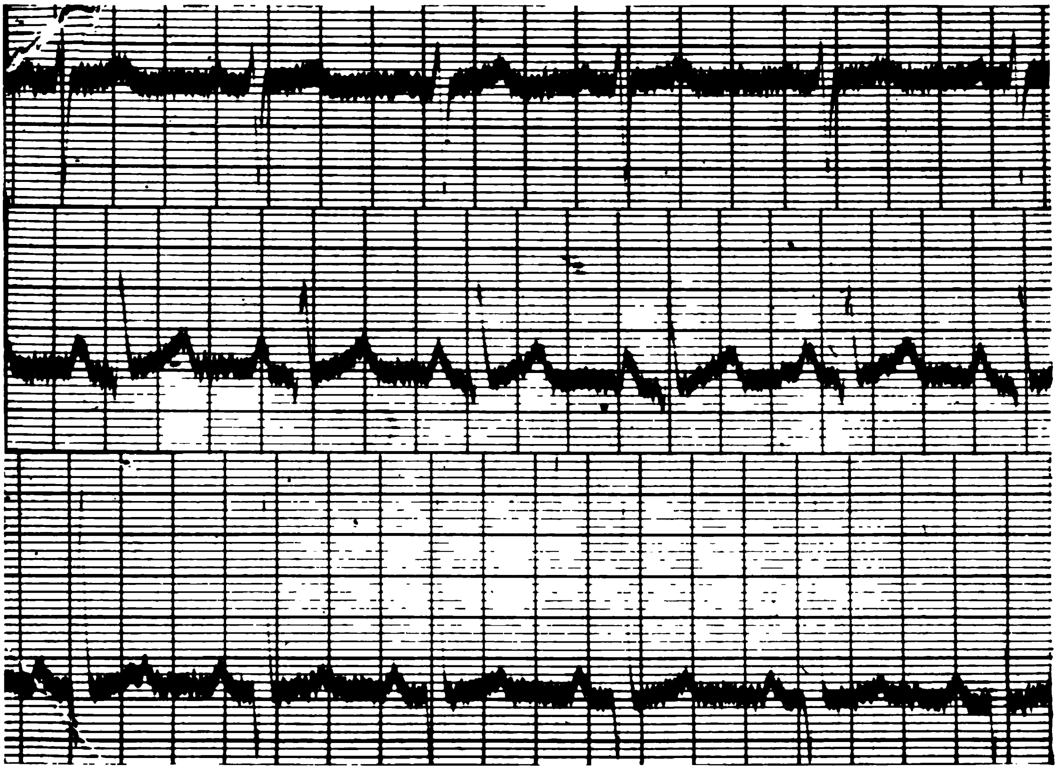
P. I. Has complained for the past four days of headaches, "hot and cold" sensations, pains all over the body, and a cough accompanied by pain in the left lower chest. This condition was diagnosed as a mild bronchopneumonia.

P. E. White boy twenty-six years old weighing 124 pounds. At the age of twelve: Heart outside the nipple line three and one half inches from the mid-sternum. No increase to the right. Action rapid and regular. Second sound at apex accentuated. P_2 equals A_2. Systolic murmur at the apex not transmitted. In the hospital with croupous pneumonia at this time.

At the age of thirteen: Heart in the 5th space in the anterior axillary line. No increase to the right. Action rapid and regular. P_2 very much accentuated and equals A_2. First sound replaced by a systolic murmur heard all over the precordia, loudest in the mitral area and transmitted to the axilla. Spleen palpable. In the hospital at this time with diphtheria and typhoid.

At the age of twenty-five: Heart apex impulse felt and seen 12 cm. to the left of the mid-sternum line. Sounds regular and of poor quality. P_2 is accenuated and reduplicated and equals A_2. Short systolic murmur at the apex transmitted to the axilla. Short diastolic just to the left of the sternum. Blood-pressure 110/60. *X*-ray showed a prominence of the pulmonary artery and a thickening of the hilus shadows and lung markings. Diagnosis, mitral insufficiency and question of bronco-pneumonia at this time.

At present: Impulse heaving. Sharp slap felt half way between the pulmonary area and the apex. P_2 greater than A_2 and much accentuated. Soft systolic murmur at the apex. Second sound loudest where slap is felt, and synchronous with it. No thrill. Blood-pressure 148/110. Sputum shows Type IV pneumococcus and blood culture shows staph. albus.



GRAPH V. Illustrating Figure 22. Marked right ventricular preponderance, a condition found most commonly in mitral stenosis, congenital heart, and chronic pulmonary disease of a type causing pulmonary artery dilatation.

monary artery. Such a picture may be obtained with a patent ductus arteriosus, a pulmonary stenosis, or an aneurysm of the pulmonary artery. It is conceivable that some form of obstruction to the pulmonary circulation might cause it. A patent ductus arteriosus is probably the most common cause. Figures 22 and 23 show rather typical cases. Hubeny[13] has written an excellent description of this condition. The appearance is so striking that the diagnosis is probably very rarely missed. An enlarged gland in the left hilus or a small sharply localized aneurysm in the descending aorta might conceivably give a similar picture, but in such cases the physical signs would be entirely different.

Syphilitic aortitis unfortunately does not always produce so typical an appearance. Of course it is impossible to detect any roentgen ray evidence of the disease until it has progressed far enough to produce some changes in the shape of the aorta. In a certain number of cases (not over 30 per cent of those coming to autopsy) the involvement is limited to the region just above the aortic valve, and a localized dilatation occurs at this point. Such a dilatation produces a prominence in the ascending aorta just above the aortic valve lesion. The discovery of these dilatations is of great diagnostic value. However, the diffuse dilatations produce pictures which resemble many other conditions, and all of the obtainable clinical evidence is needed in attempting a diagnosis. Figure 26 illustrates such a condition. If the aneurysms had not been discovered, this arch would in all probability have been called arteriosclerotic, and no doubt the patient had definite arteriosclerosis. However, it seems fair to assume that a syphilitic infection general enough to involve vessels in the neck and in the abdomen would hardly miss the aortic arch.

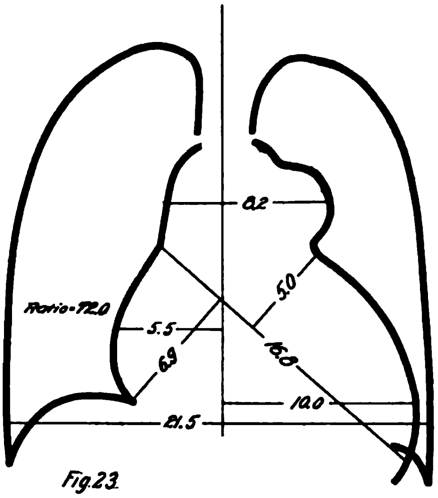


FIG. 23. Dilated Pulmonary Artery. (Case seen at Baylor Hospital, Dallas.) P. H. Mother states that doctors were interested in the child's heart shortly after birth. There have been several febrile attacks of an unknown character.

P. I. Patient is semistuporous and a good history is not obtainable. Mother thinks that patient was fairly well until three months ago when she began to complain of dyspnea and orthopnea. At present she is coughing up a bloody sputum and running a temperature ranging between 99 and 103 degrees F.

P. E. The patient is a fairly well developed negro girl thirteen years of age. At admission the temperature was 103, the pulse 144 and the respiratory rate 46. Râles are heard in the lower left axilla. The left side of the chest is slightly more prominent than the right and a diffuse heaving impulse can be seen covering most of the precordia. The heart is definitely enlarged to percussion both to the right and to the left. A systolic thrill is felt in the pulmonic area. The pulmonic second sound is accentuated and reduplicated. There is a loud systolic murmur heard loudest in the pulmonic area and transmitted upwards on both sides of the neck but best on the left. The white count is 34,800. The urine shows a few hyaline casts and pus cells.

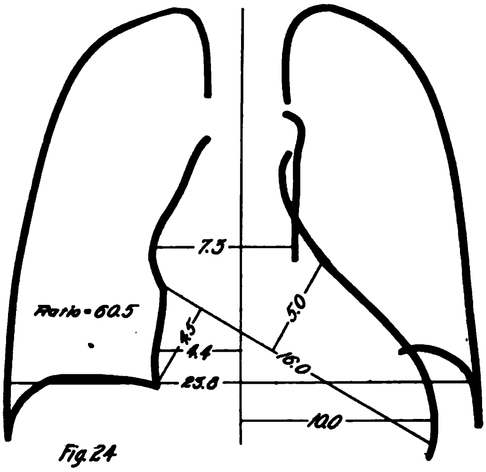


FIG. 24. Specific Aortitis Long Unrecognized. O. P. D. 181357. 1911. Jewish woman of fifty weighing 155 pounds comes in complaining of continual cough with non-purulent sputum, dyspnea, pain in the throat and back, and some incontinence of urine. Examination shows A_2 accentuated, heart not enlarged to percussion, a blood-pressure of 150 (systolic) and the bases of the lungs full of râles. A diagnosis made of bronchitis.

1912. Cough still present. Worse at night. Raises little. Feels weak. No murmurs made out in heart examination. Blood-pressure noted at 130/80.

1913. Cough worse but non-productive. Marked dyspnea on exertion. A_2 greater than P_2. Soft systolic murmur heard in aortic area. Blood-pressure noted as 135/90.

1914. Old symptoms still present. Pain has appeared in left back and in wrists and ankles.

1915. Blood-pressure noted as 180 (systolic). Treated in dental clinic for apical abscesses. Treated in throat room for pain in throat without a definite diagnosis. Treated in orthopedic department for pains and wrists and ankles. All of this treatment failed to clear up original symptoms.

1916. Admitted to the hospital for study. Wassermann negative. Discharged after a week with diagnosis of: Question of cholecystitis, chronic pyelitis, cystitis, and a question of mitral disease.

1917. Admitted to hospital a second time. Discharged with the diagnosis of: Senile heart, chronic arthritis, obesity, and a question of myxedema. Blood-pressure noted as 140/90.

1919. Comes in complaining of hoarseness, cough, a feeling of anxiety, dyspnea, and some palpitation. Examination of the heart shows the sounds regular and distant, a systolic murmur heard all over the precordia and transmitted to the neck, and a diastolic murmur in the aortic area.

DISCUSSION

These few cases show in a general way the more striking morphological differences in various types of cardiac pathology. Prognosis and treatment are now based to a large extent on hypertrophy and dilatation, that is on the condition of the cardiac muscle rather than on the nature of the lesion present. Accurate records of changes in size and shape taken at regular intervals are of the greatest value to the cardiologist. Those who refuse to avail themselves of such aid are merely disregarding one of the more accur-

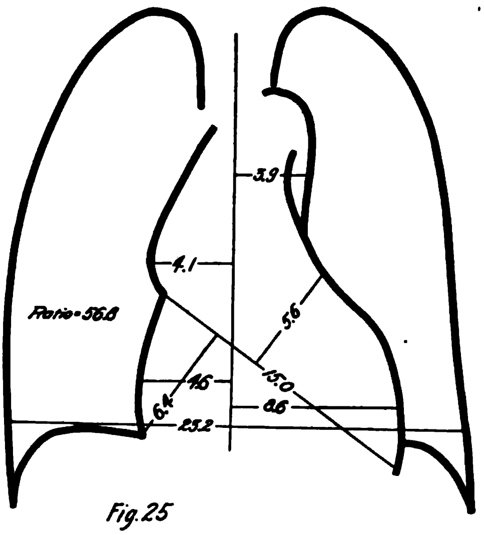


Fig. 25. Specific Aortitis and a Tremor of Syphlitic Origin. O. P. D. No. 392668. P. H. Has had typhoid, scarlet fever, and gonorrhea. Also a penile sore some years ago.

P. I. Slight tremor appeared in left arm five years ago. Remained constant and of the same intensity for three years. It then extended to the left leg and right arm two years ago and has been getting worse. Some shooting pains recently in legs. Otherwise feels well and strong.

P. E. White man. Age forty-three. Weight 140 pounds. Left arm shows a constant tremor. Right arm and left leg show the same phenomenon to a less degree. Tremor diminishes while performing purposeful movements. Right pupil slightly irregular. No reaction to light and distance. Slight systolic murmur in the aortic area. A_2 greater than P_2. Blood-pressure 170/110. Lungs negative. Knee jerks absent.

Laboratory Findings. Blood Wassermann moderately positive. Spinal fluid shows 31 cells per cubic millimeter, an increased pressure, and a strongly positive Wassermann reaction.

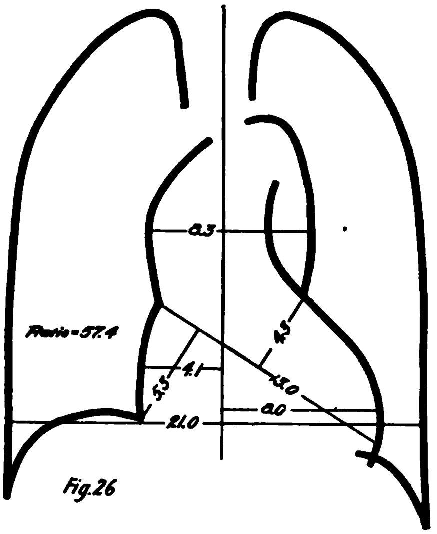


Fig. 26. Multiple Aneurysms. Case No. 231966. P. H. No children's diseases. One child lived to be twenty-one but died of tuberculosis. Four miscarriages. "Gastric catarrh" evidenced by abdominal distress and backache for many years. Married thirty years. Says husband is well. No alcohol.

P. I. For past five months she has had an attack of dizziness and vomiting about once a week. Attacks last one or two days. Well between attacks. At times she has a pain in the back which is made worse by exertion and on several occasions has been transmitted down the arm (left) and accompanied by tingling in the fingers. Progressive loss in weight, 70 pounds in four years.

P. E. White woman. Age fifty. Weight 100 pounds. Small pulsating mass felt and seen in the base of the neck on the right side. Systolic bruit heard over this tumor. Firm, round, somewhat tender pulsating mass in upper right quadrant of abdomen about the size of an orange. No bruit heard over this tumor. Heart sounds regular, rapid and of fair quality. A_2 greater than P_2. Slightly accentuated. Loud blowing systolic murmur at the base heard best over the aortic area and transmitted to the neck. No thrills. Blood-pressure 225/140. Arterial walls palpable, tortuous, and markedly sclerosed. Urine shows a slight trace of albumin and a few red and white cells at two examinations. Red count 3,000,000. Hbg. 70 per cent. Wassermann negative.

ate scientific methods at their command.

It may perhaps be wise to utter a word of warning to the enthusiastic roentgenologist who would attempt cardiac diagnosis. Clean-cut cardiac lesions are not particularly common, and the combined lesions that may appear often tax the skill of the best internist with his various methods of investigation. Certain stages in various cardiac disorders produce shapes of the heart outline that are almost identical. If, instead of trying to make a diagnosis, the roentgenologist sends the internist a description of the cardiac shadow and states whether or not it is enlarged and denotes the chambers or vessels which show enlargement, he is rendering a service that is based on sound scientific principles, and one that should be deeply appreciated by the physician receiving the report.

SUMMARY

1. The cardiothoracic ratio offers an easy and accurate method of determining cardiac enlargement.

2. The demonstration of a small heart is often as helpful as the demonstration of a large one.

3. Diseases of the myocardium, endocardium, pericardium, great vessels and kidneys produce cardiac shadows of different shapes, some of which may be used as points in differential diagnosis.

I wish to express my deep appreciation of the assistance rendered me by Dr. Geo. W. Holmes, Dr. William H. Smith and Dr. Paul White. Without their aid and instruction the preparation of this paper would have been impossible.

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AN ANALYSIS OF ELEVEN HUNDRED ROENTGEN EXAMINATIONS OF THE GASTRO-INTESTINAL TRACT[*]

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Charlotte Sanatorium

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In making an analytical study of the symptoms and roentgen findings in a series of cases, there is much additional information that one would seek if it were possible again to marshall the host before him. He would note the previous operations very carefully. He would pin the patient down to some definite, outstanding symptom, instead of accepting the vague replies that are made, as "indigestion," "gas," "general discomfort," etc. So we find in reviewing our cases that there are many points we would like to know. We have tried to work with an open mind, inquiring into these points after our diagnosis was formed, consequently some points were necessarily overlooked.

In this series we try to note the principal symptom, or at least the symptom that drove the patient to seek medical attention. It has been difficult to follow the cases because the work was done in different hospitals, and often the patients came from doctors and surgeons in distant towns and returned to them for treatment; so the operative and clinical findings were not always secured.

There were two conditions that led to this study. First, the frequency of the epigastric pain as a presenting symptom, often resulting from pylorospasm, due to appendix or some other exciting cause. Second, the frequency of the occurrence of chest pathology in the cases presenting gastric troubles. When the study was almost finished I was pleased to hear a paper by Drs. Christie and Groover[1] on this latter subject at a meeting of The American Roentgen Ray Society.

This series of gastro-intestinal cases numbered eleven hundred, and showed the proportion between male and female to be almost equal, women 516, men 584.

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[*] Thesis presented with application for membership in The American Roentgen Ray Society.

TABLE I

PRESENTING SYMPTOMS

Vague digestive and nervousness	390
Epigastric pain	207
Right side pain	180
General abdominal discomfort	139
Gas	66
Biliousness and vomiting	36
Headache and nausea	14
Diarrhea	12
Difficulty in swallowing	11
Abdominal mass	9
Constipation	8
Pain in left side	7
Jaundice	4
Anemia	4
Cerebral symptoms	2
Urticaria	2
Obstruction	2
Vomiting blood	2
Epilepsy	1
Paralysis agitans	1
Rectal pain	1
Loss of weight	1
General arthritis	1
	1100

In the series the largest number, 390, came complaining of general indigestion, or indigestion and nervousness and malaise. They are classed in the table as "Vague Digestive". The next in frequency was 207 epigastric pain. These cases varied from intense hunger pain to the vague discomfort, and include those subjective symptoms upon which the clinician usually bases his diagnosis of ulcer.

Following this, we find right side pain with 180 cases. I have not attempted to classify this symptom. It includes the pain, front and back, high and low, on the right side, and the number seemed sufficient to demand attention. Of the physician's *bête noir,* left side pain, I note only seven cases.

Next we notice a symptom that is really rather common, general abdominal discomfort, with 139 cases. This, like indigestion, covers a multitude of sins, varying everywhere from a fullness to a diffuse, general pain, a complaint which is even more common than this number would indicate. While in this series there are only ten or fifteen colored patients, we might say that one rarely sees a patient of this race from whom this symptom cannot be elicited.

Following this come 66 cases with a group of symptoms that the general practitioner meets frequently. The patients give a list of symptoms generally starting with "gas," "sour stomach," "heart burn," "belching," etc., and if they are "fair, fat and forty" the clinician thinks of some gallbladder trouble.

The next 36 cases present symptoms that also sound familiar—frequent bilious attacks with vomiting of bile and often nervousness and sick headache.

The other symptoms shown in Table 1 need no discussion since they represent a rather large variety and very few are of special interest.

Now in regard to the roentgen findings, since some cases present two or more pathologic conditions which are difficult to tabulate, but where a certain condition is the most noticeable, this is chosen. There are only 107 cases reported as negative, but if the list were culled carefully other cases would fall under this head, since findings were reported other than those which pertain to the gastrointestinal lesions.

While the most frequent diagnosis made is the appendix, and while I am fully convinced that it does influence the digestive tract, the writer agrees with Pfahler[2] and others in regard to this much maligned organ, and believes that if the patient with a barium meal is constantly watched, at some hour during its passage the organ can generally be demonstrated. But here I have classed as chronic 117 of the 301 cases, these being the cases that showed adhesions, tenderness or constriction, or that retain barium some time after the cecum is emptied. The 141 that are reported as simply patulous, while they were not pathological were conceded to be potentially so. Furthermore, those combined with stasis and ulcer were most probably of the chronic type. It is interesting to note that 33 per cent of duodenal ulcer cases were accompanied by a patulous and chronic appendix. Attention of the gastro-enterologist and surgeon was called to this and in many cases a pathological appendix was found. Certainly the occurrence is frequent enough to suggest to us the plausibility of a theory as to the cause of duodenal ulcer, viz., that the chronic appendix reflexly causes a pylorospasm or duodenospasm, and that this is followed or accompanied by a hyperacidity, possibly causing or contributing to an erosion which gives a seat for the invading organism.

Of the class of cases, numbering 46, diagnosed as dilated duodenum, which showed as a rule the symptoms outlined by Vanderhoof[3]—nausea and vomiting, bilious attacks, headaches and nervousness—many were due to extreme ptosis of the stomach, some to adhesions, and one or two were accompanied by lordosis. Only one was of the extreme type referred to by Engelbach[4] and I believe only one came to operation.

In regard to chest conditions, although they are amply sufficient to demand consideration, we do not have quite as large a percentage as in the series of Christie and Groover.[1] This is possibly due to the fact that only in the cases in which routine fluoroscopic observation seemed to indicate did we make a plate for careful study. The lungs showed pathology in 47 cases and the heart and aorta in 29 cases, giving a little over 7 per cent in which the chest pathology was at fault. This does not include many cases in which there was pathology here and a frank lesion in the alimentary tract, but only those cases in which this condition was the principal lesion observed.

In our laboratory it is almost a routine to examine the teeth, certainly any suspicious ones. And in these thirty-one cases, while the rest of the alimentary tract was negative, they were considered sufficiently bad to suggest that they might be causing some trouble.

In regard to the liver and gallbladder region, the pathology was located here in 110 cases; 35 of these carried a report that we dislike to give—"suspicious gallbladder," but since evidence was not conclusive this term was used. I am unable to say how many of the 22 reported as gallstones were confirmed by operation, certainly the majority.

The frequency of cancer in this series has been striking, but this I believe is explained by the fact that our clientele comes from a large area of country, and that, as is well known, these cases go to specialists only as a last resort.

TABLE II

ROENTGEN FINDINGS

Negative		107
Appendix		301
with ulcer	21	
with stasis	22	
chronic	117	
patulous	141—301	
Stasis colon		79
Stasis small intestine		4
Spastic constipation		53
Duodenal ulcer		28
Gastric ulcer		28
Pylorospasm		18
Dilated duodenum		46
Gallstones		22
Suspicious gallbladder		35
Cholecystitis gallbladder		39
Kidney stones		9
Cancer		55
Gastric	32	
Colon	7	
Rectum	2	
Gallbladder and liver	9	
Esophagus	4	
Pancreas	1—55	
Cardiospasm		6
Diverticulum of esophagus		1
Dilated heart and aorta		29
Pulmonary tuberculosis		47
Bad teeth		31
Intestinal obstruction		2
Pyloric stenosis		2
Colitis		31
Gastritis		2
Duodenitis		2
Incompetent ileocecal		13
Ulcer rectum		3
Adhesion ileocecal		23
Abscess sub-diaphragm		2
Abscess liver (amebic)		1
Abscess pelvis		1
Abscess spleen		1
Ptosis stomach		20
Ptosis colon		7
Ptosis intestines		9
Ptosis kidney		6
Syphilis stomach		9
Syphilis liver		2
Pelvis tumor		1
Hernia with adhesions		3
Hyperthyroid		7
Redundant colon		2
		1100

Under the head of pylorospasm, used here in the sense of irritable or spastic, there are only 18 cases. There is always a cause for this condition but these represent the cases in which no cause was located. My observation has been that it generally manifests itself in epigastric pain, which brings me to the study of the 207 cases presenting this symptom. (See Table III.)

TABLE III

EPIGASTRIC PAIN

Chronic appendix	75
Duodenal ulcer	44
Gastric ulcer	18
Pylorospasm	14
Duodenal ulcer and appendix	15
Gastric carcinoma	7
Gallbladder with pylorospasm	6
Kidney stones with spasm	5
Cecal adhesions	5
Spastic constipation	5
Bad teeth and spasm	4
Negative	4
Dilated aorta	2
Duodenitis	2
Dilated duodenum	1
	207

Of the findings in these cases the ulcer cases, carcinoma, and possibly the cases of duodenitis, or about 86 cases, would cover those having sufficient lesion to explain the pain. In the remaining 121, the pain must have been due to pylorospasm; in all but 14 there was some cause found, and I feel that if a closer study could have been made in the cases marked "Pylorospasm" alone, the cause might have been determined. It is striking to observe how many cases of chronic appendix were observed here, also the frequency of the location of the lesion elsewhere, as kidney, gallbladder, and colon.

There are many other interesting points that have arisen in the study of these cases, but it is not necessary to mention them at this time.

I wish to thank Dr. W. O. Nisbet and my other associates for their assistance in working up these cases.

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CONGENITAL ATRESIA OF THE ESOPHAGUS*

By E. H. SKINNER, M.D.

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THE rarity of case reports upon congenital atresia of the esophagus in roentgen literature prompts a report of the following case seen in consulation with Dr. Frank C. Neff, of Kansas City.

In this condition the upper third of the esophagus usually ends in a blind cul-de-sac which is often dilated (Adami, Page 397). The lower part may be absent completely, or the lower portion forms a fistulous opening into the trachea or bronchus. The embryological explanation of these cases is lacking. Cautley classifies malformation of the esophagus into eight general divisions. His article is quite expansive and it should be consulted by anyone interested in following up this kind of case.

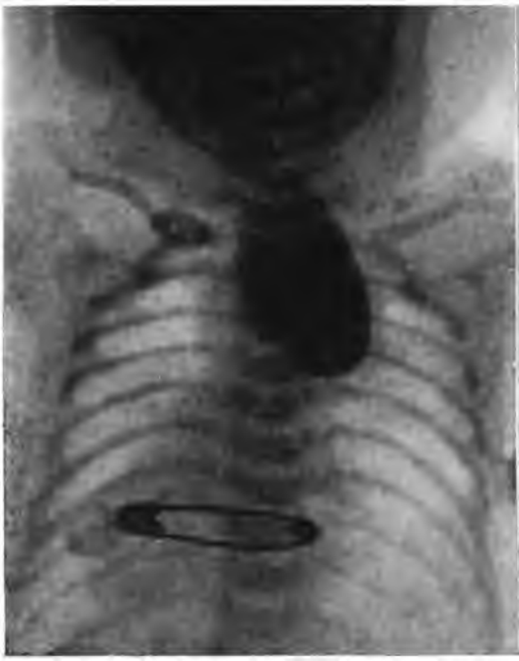

FIG. 1. Antero-posterior projection showing complete obstruction of the esophagus above the atresia with dilatation.

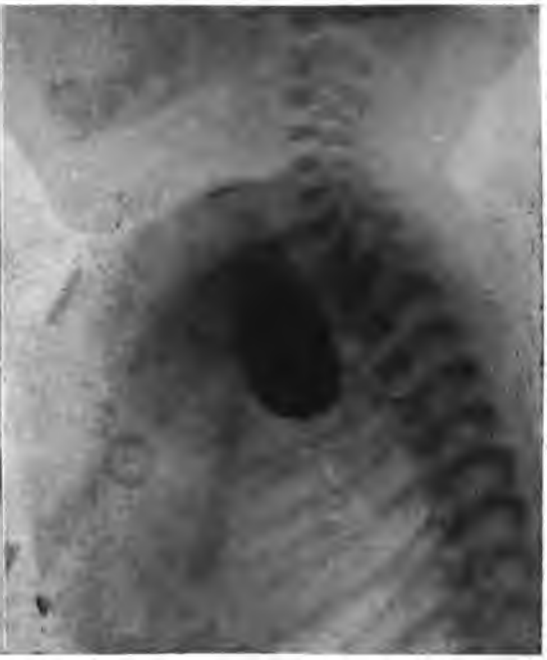

Fig. 2. Oblique projection showing the same condition.

CASE REPORT

Baby V. H., girl, born October 25, 1920, weight six and one-half pounds. Four brothers living and well; one sister dead, cause not known. Parents well. This child was two weeks premature, but delivery was normal. Vomited all the milk immediately after each breast nursing.

This baby was seen in consultation upon the fourth day of life and appeared to be well nourished, with a grunting respiration and normal temperature, no pyloric tumor, no peristaltic wave, and with a history of having vomited every nursing, although the child appeared to be hungry and nursed eagerly.

The little patient was brought to the laboratory sandwiched between two hot water bottles. Barium was mixed into breast milk in a nursing bottle. The baby eagerly nursed this from the bottle. The fluoroscopic examination showed a cul-de-sac formation reaching just below the clavicle to the level of the fourth dorsal vertebra. It was of a character and size frequently seen in adults suffering with a Zenker's diverticulum. The lower margin of this pouch was smooth and rounded with absolutely no evidence of any canalization of the lower two-thirds of the esophagus As soon as the cul-de-sac was filled with the barium suspension the child began to vomit but did not relieve the cul-de-sac entirely.

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*Read at the Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., Feb. 21, 1921.

The attached illustrations were taken in the dorsal position of the patient and in the antero-posterior and lateral planes. They represent quite exactly the size and outline observed with the fluoroscope.

The subsequent history of the case is brief. Inasmuch as inanition was imminent and complete obstruction apparent, a gastrostomy was performed the following day and the baby lived forty-eight hours following the operation, during which time two teaspoonfuls of breast milk and warm water were fed through the fistulous opening into the stomach every hour.

The autopsy revealed that the esophagus ran down to the level of the bifurcation and ended in the form of a pouch with a fibrous band attaching it to the trachea. Extending up from the cardiac end of the stomach was the lower portion of the esophagus with a patent lumen for about 2 cm. At this point it disappeared, becoming fused with the mediastinal tissue. The stomach was small but of normal development.

This case corresponds with type 7 (b) as classified by Cautley.

There have been two case reports of the atresia of the esophagus in American pediatric journals, which also carry roentgen illustrations. These are cited in the following bibliography.

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DISCUSSION

Dr. A. W. Crane. Some years ago we had a case of atresia of the esophagus which was exactly the same as the case just reported. After the baby's death we brought the body to the office and did a postmortem. We injected a barium mixture into the stomach through the pylorus. This mixture filled the esophagus from below, and when *x*-ray plates were made, an anastomosis of the lower esophagus with the trachea became apparent.

There have been quite a number of cases reported at the Chicago clinics. In all of these, so far as we have records, a communication between the lower portion of the esophagus and the respiratory apparatus was found. Death would of course invariably result in all of these cases.

Dr. L. T. LeWald. We had a case of this sort in which demonstration was made by a catheter passed into the esophagus, and then an *x*-ray exposure was made which showed the point of obstruction.

In all the cases of this sort observed at the New York Lying-in Hospital there was a communication between the lower portion of the esophagus and the respiratory tract.

I would like to ask Dr. Skinner if there was any communication in his case?

I know of four or five cases which have been operated upon unsuccessfully because the communication between the stomach and the respiratory tract was not recognized. The surgeon should close the cardiac end of the stomach in addition to performing a gastrostomy.

Dr. E. H. Skinner. Replying to Dr. LeWald; there was no trachea-esophageal fistula in this case. Such types are, however, more frequently encountered.

X-RAY WORK FROM THE VIEWPOINT OF AN INTERNIST

By GEORGE DOCK, M.D.

ST. LOUIS, MISSOURI

I CANNOT appear before this body without thanking your President for the honor conferred on me by the invitation. Coming from him, it seemed a command as well as an invitation, for I am under an old debt of gratitude to him for his keen and enthusiastic cooperation in my clinic before he took up the work to which he has since devoted himself with great success.

I have other reasons for appreciating the invitation to address your meeting. I have had a long-standing interest in *x*-ray work and have been in almost daily contact with roentgenologists since I was initiated into the possibilities by such masters as Crane, Hickey and Hulst. Nor can I forget that cheerful co-laborer, Vernon Willey, whose death cut short so much promise. Later I had the association of the genial Granger in New Orleans, and of Russell Carman and Walter Mills here. I began with the crude fluoroscopy of the earliest days, guided by technicians skilled only in electricity and photography, but soon I realized the great extent and seriousness of the subject and was glad to depend upon experts with whom I have long worked intimately, combining thus the clinical and radiological points of view.

I shall speak chiefly from the clinical standpoint, but as one who finds radiology as indispensable as percussion or the microscope, and demanding the same devotion to make it a success. This leads to some consideration of specialists, concerning whom so much has been said, and so much that is contradictory. The contradictions have often been due to the differences in specialists and specialties, and those relating to roentgenologists will be repeated in the case of many other technical methods in future as they have in the past.

Novelties in medical diagnosis are taken up and cultivated by people of all ages and degrees of experience or inexperience. If the work is of a kind requiring not only skill, but also complex, costly and rapidly changing apparatus, it cannot be taken over generally as can simpler methods. We can compare physical diagnosis or urinary microscopy and the simple urine chemistry on the one hand with serology, radiology and blood chemistry on the other. The work then forms not a medical specialty, like ophthalmology or internal medicine, but a technical specialty. If the one who cultivates it has little or no medical training he remains a technician unless by a combination of mental gifts, opportunity and hard work he acquires the other necessary knowledge. The more widely experienced man who cultivates a new technical method, acquires the physical equipment and uses it along with his other methods, becomes of course a broader and more efficient man than he was before, a higher type of specialist. If he chooses to hand over the more mechanical part of the work to an assistant or servant, he is still at an advantage over those who have all that he has except the finished technical knowledge, just as he also has an advantage over the technician, no matter how much of a virtuoso the latter may be. If such a man as I have described has a fairly large amount of work, if he does original investigating, keeps up with the literature of the subject, attends special meetings, visits other laboratories, imparts his knowledge to others through addresses, articles and books, he occupies just as important a position as any specialist and will have the same sort of recognition. At another end of one class we find a specialist who cultivates roentgenology only as an aid to his clinical work—the tuberculosis specialist, gastro-enterologist, etc., whose work will be legitimate if it is good.

As in other lines of medicine the difference in the ability of roentgenologists is not known by the public, or even by all physicians in their spheres of activity. So we see men asked to make diagnoses or to do operations for which they are not fitted; to refuse to act is sometimes more than human nature can stand, but consent is fraught with danger to patient and reputation. Not even organizations such as special societies or national "colleges" can stop this, nor probably anything else except greater enlightenment and publicity regarding medical work.

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*Read at the Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., Feb. 21, 1921.

There is room in every city of considerable size for roentgenologists of the highest type. Other specialists will be glad to obtain their services in many cases. Family physicians and general practitioners must constantly call on them for assistance. But many such specialists will suffer from the necessity of covering too large a field ever to become preeminent in any one department, such as bone, chest or gastro-intestinal work. It will probably be best for the roentgenologic specialist to specialize still more, and it would be well, where there is more than one in a city, for each to restrict his work to the line or lines in which he is most skilled. In this, as in so many other aspects of medical life, cooperation offers the most desirable conditions for work, and a group of roentgenologists might also be part of a larger and more varied group of specialists, until they form the most complete team.

Roentgenology furnishes an interesting light on changing conditions in medical economy. Formerly hospitals and medical scools were the nurseries for new and developing technical methods and technicians, but both these kinds of institutions are likely to have restricted budgets, and it is often impossible for them to furnish the few or many thousand dollars necessary to equip and conduct such a thing as an *x*-ray department or a radium supply, just as it is impossible to equip and conduct a chemical laboratory or modern bacteriological laboratory or heart station. Those who work in universities, as a rule, have no private capital for such purposes, and so the demands can usually be met only by specialists with large practices, or by groups of specialists with initiative as well as credit.

Leaving this rather material but essential phase of the subject, let me consider another. An important fact about medical diagnosis, often overlooked, found in *x*-ray as it is in other kinds of work, is that positive findings are, as a rule, of limited application, and must be combined with others to give them clinical value. It has taken a long time for physicians to recognize these truths, and many do not bear them in mind even now. For centuries there was a search for pathognomonic signs, and these were but slowly relegated to a subordinate place as their lack of certainty was demonstrated; but each new method still revives the same sort of hope. Dozens of methods of percussion have been devised, and hundreds of stethoscopes invented, with the hope that each one would give unequivocal results. Hundreds of men worked at urea determinations believing that if they could only get the right method they would end all trouble in the diagnosis of protein metabolic errors, gout rheumatism and what not. Men have deluded themselves into searching for cancer cells, for cells characteristic of limited areas, such as the ureters and the renal pelvis. Even now, although the fallacy has been known for years, men will titrate for hydrochloric acid in stomach contents, solely to recognize or exclude cancer of that organ, and for some years many will think that a basal metabolism determination will save all the minute examinations of a large and varied clinical material. In roentgenology, many had an idea in the beginning that with its aid one could do for a gastric ulcer or tumor what the gastroscope had failed to do—make it it visible as certainly as the ophthalmoscope makes retinal hemorrhage or a choroiditis visible.

The truth is that discoveries in diagnosis do not shorten or make easier the work of diagnosis. They make it more accurate, they make it fuller, but only by enlarging the manual work of the diagnostician and calling for a greater capacity for generalizing. The same sort of disappointment followed the finding of tubercle bacilli that so often follows the fluoroscopy or skiagraphy of the thorax in certain cases. In each case one hoped that the tedious task of history-taking, physical examination and repeated physical examination and of laboratory tests would be avoided. The dream was, and still is, to endeavor to detect and treat the disease, instead of treating the patient. Very slowly do the real facts appear, and these have different values for each method of manipulation. So the finding of tubercle bacilli in the sputum is positive evidence of tuberculosis, but where, how much, in what form or stage, how virulent and all the rest of the patient's condition, must be worked out by other methods. The finding of elastic tissue in sputum was once expected to do what it was later hoped tubercle bacilli would do—shorten the task of diagnosis. It was long since abandoned for that purpose, and is not used now as much as it should be, for it is easy to find when present, and when found gives proof of a fact that cannot be demonstrated as certainly in any other way, including the use of *x*-rays, viz., the breaking down of the lung, or cavity-formation. But here too the situation and extent of the breaking down must be worked out by other methods, including roentgenologic ones.

Here I may be allowed to comment on some of the features of lung diagnosis with reference to *x*-ray work. The application of *x*-rays to lung pathology was no greater innovation in its time than the use of percussion and auscultation a century earlier. Both the latter became useful very soon after they were applied, because they had been tested by the results of other clinical methods and of postmortem examination by their discoverers and others. Not only what they could reveal, but what they could not reveal, were made clear within a short time of their application. Only details were added later, and these depended upon other new technical methods, or upon additions to pathologic anatomy and etiology.

Roentgenographic methods as applied to the lungs do not differ essentially from auscultation and percussion. All depend largely on differences in density of the structures concerned, and on physical facts relating to density. There is another similarity. Auscultation and percussion are strongly personal methods, affected by the special senses, tact and technical skill and by experience and accurate thinking on the part of the examiner. I think that in roentgenology the same qualities are all necessary, with the additional drawbacks of the freaks of machinery and electric currents, of screens, plates and reagents. The same things that affect auscultation and percussion in the body of the patient—thickness of chest wall, size of thorax—affect the fluoroscopic picture and the skiagram. I think it is a fact that *x*-ray work on the lungs was not controlled by anatomic investigation to the same degree that auscultation and percussion were. This was due partly to a general decline in postmortem examinations that seems to be getting worse instead of better, and further due to conditions too complicated to consider in detail at this time. But it depended also, I think, very largely on the fact that many *x*-ray specialists had little knowledge of lung diseases, and especially had no familiarity with either the gross or microscopic conditions in lung diseases. Yet on account of the striking results of *x*-ray examinations of bones, early roentgenologists were forced into the position of lung diagnosticians with extraordinary powers.

The sources of difficulty in roentgenologic examinations of the lungs did not, in the beginning, and do not now seem to be recognized as accurately as they should have been and should be. For example, with percussion it was easily shown that in order to alter the percussion sound, a lesion must reach a certain size and lie within a certain distance from the chest wall, and with recognizable sources of confusion in the chest wall itself. With *x*-ray work many technicians assumed from the beginning that all lesions could be made out in the screen or plate, and boldly made diagnoses of things they had never seen before. In the beginning inferior screens and imperfect technique were unavoidable. With inferior technique the *x*-ray plate gave a set of silhouettes of planes showing areas of varying density superimposed on each other. With better technique, including the stereoscope, it gave an infinite number of perspective views superimposed. In both cases something between one third and one half of the field were obscured by those dense structures, the ribs and heart. Yet in spite of these difficulties much excellent work was done—much work of very great value clinically—and for this result the small number of close students of anatomic and *x*-ray examinations and a comparatively small number of talented and cautious technicians must be thanked.

X-ray methods should be applied much more freely to the study of lung diseases than they are now, not only for the certain additions they will make to knowledge, but for their practical value. They can confirm many points disclosed—but not fully enough—by auscultation and percussion. They make clear in certain cases that what had been a bronchitis is really a pneumonia or some other process affecting the air cells or the blood vessels, lymphatics or interstitial tissue of the lungs. They can reveal a process that was often suspected on using older methods, but could not be proved by them, such as an infiltration of an inner edge of a lung, or an effusion between lobes not reaching the surface to an extent permitting recognition by percussion.

They have shown the not infrequent existence of small pneumothorax cavities in various parts of the thorax. This may not be as important a finding as some others, but adds much to our knowledge of thoracic pathology. But here one may mention an important clinical fact, the kind of fact that cannot be lost sight of in discussing diagnostic technique. Any one with a rather wide observation of *x*-ray reports on thoracic cases will see some in which even a large pneumothorax is not recognized in the fluoroscopic plate, though it may be by physical signs, and on the other hand, cases are said to have pneumothorax when further *x*-ray and other examinations show nothing more than an artefact.

Another condition not yet investigated by roentgenologists as much as it deserves, is atelectasis, including the interesting form described as massive collapse of the lungs (W. Pasteur and others).

Physical diagnosticians always lay stress on repeated examinations, having learned that a single one is likely to be incomplete. In striking contrast to this is the confidence with which many *x*-ray specialists will make a positive diagnosis from a single examination and sometimes a prognosis. Even more, patients are ordered to Arizona or California upon the finding of an enlarged hilus shadow or of density in the apex, without further inquiry.

Physical diagnosis is notoriously beset by the perils of a strong personal equation, and physical diagnosticians are rightly expected, by those who seek their help, to explain on what grounds they base their conclusions. The personal equation in the interpretation of *x*-ray findings is present too, though perhaps not to so great an extent; and yet we find *x*-ray specialists who refuse to show plates to physicians consulting them, but hand out ex-cathedra diagnoses from which there is no appeal. I admit this is rather uncommon, but that it exists imposes upon the specialty the task of reforming its practitioners.

The *x*-ray specialist is at a serious disadvantage in the matter of following up cases. In physical diagnosis we learn much, in cases not coming to autopsy, from the sequence of events. But the *x*-ray operator can only do this with inconvenience to the patient—sometimes impossible to overcome—and expense to someone. This matter of expense is one of the most potent causes of the backward condition of thoracic *x*-ray work. If *x*-ray plates were as easy to get as temperature charts how rapidly could we enlarge the comparison of *x*-ray and anatomic results, as shown by the valuable serial study of influenza-pneumonia by Sante! But the cost of material and the time of technicians prohibits this work almost wholly. The difficulty of financing such essential work, in contrast with the ease of financing measures for destroying life, is one of the most depressing phenomena of the time we live in.

Among unscientific practices in *x*-ray work on the chest may be mentioned the unfounded confidence on the part of many in the interpretation of shadows of the hilus region. All who have had postmortem experience know how often the glands in the roots of the lungs become enlarged. They become so by congestion and edema in many cases of bronchitis and bronchopneumonia; they become so on account of tubercles, many of which heal, leaving calcified or fibrous areas very often; they become so on account of various causes of irritation, many of which leave no other evidences of danger than the enlarged shadows. I have often been told of cases or have seen reports in which such enlargements were given an exact etiologic name; viz., tuberculosis, but I have never had demonstrated the grounds on which the diagnosis had been made, except as regards calcification.

Pathological-anatomists are also familiar with many cases in which there are areas of disease of varying sizes, from those barely visible to the naked eye up to the size of hempseed, that cannot be differentiated by the naked eye, and under the microscope cause much difficulty. These are especially bacillary tubercles, gummas, miliary carcinomas and lymphomas, but sometimes actinomycotic granulations or other processes. All of these and some other dense areas that I cannot explain are likely to be called miliary tubercles if they show on the screen or plate. It is not less surprising to see the confidence in the diagnoses than the belief that the diagnosis of miliary tuberculosis, without further qualification, is of any great value.

Anatomists know that miliary tubercles may occur in very small numbers, so that they might be visible singly on the plate. But these are often of slight clinical value. They occur in that form either as terminal lesions in fatal cases, or heal without having been suspected during life. Clinically, miliary tuberculosis of the lungs is well known, though not always easy to recognize. In the great proportion of cases in which I have known the *x*-ray diagnosis to be made, it has not been borne out by the further course of the disease, if favorable, or the autopsy, if fatal, and in many cases fairly extensive tuberculosis has been present without being suspected by the radiologist.

Larger areas of density in the lungs are also frequently asserted to be tuberculous, but I am not aware of any criteria by which one can distinguish between, let us say, catarrhal lobular pneumonia in influenza or other conditions, tuberculous bronchopneumonia, and other similar focal processes. A fact familiar to all clinicians who utilize *x*-ray work, but too often overlooked by technicians is that very often pin-head or hempseed sized lesions are shown on the plate, but larger ones may be missed, even up to those that give physical signs. It is interesting to see that the *x*-ray diagnosis of cavity is still missed in both senses—diagnosed when not present, overlooked when present in considerable volume.

A common mistake made by *x*-ray operators is often made also by physical diagnosticians. There is some excuse for it, as the mistake was once made by Laënnec himself, but it should be avoided by a habit of caution. The situation is as follows: A patient known to be tuberculous, or found to have a suggestive history and signs of a lesion in one apex or both, shows signs of a bronchopneumonic process in one or both of the lower lobes, or even more. The *x*-ray plate, like the auscultation, shows a widespread bronchopneumonia. It is assumed to be a peribronchial tuberculosis or bronchopneumonia and a bad prognosis is given on account of the wide extent, but it may be a simple coccus inflammation of mild virulence and may rapidly clear up, with much adverse comment on the part of those who observe the obvious mistake.

This reminds me of the frequent note "active" in connection with a diagnosis of tuberculosis by *x*-ray specialists. I have never had anyone demonstrate the reason for such a diagnosis when based on a single examination. One can say that a calcified area, on the other hand, is evidence of an old lesion. Most probably it is inactive, yet it may liberate viable bacilli at some time and become active. The work of Opie on calcification in the lungs and other organs should be carefully studied by radiologists, not merely for the technical bearings, but even more on account of their relation to prognosis.

I also view with scepticism the *x*-ray diagnosis of tuberculosis of an apex, since the only tuberculous lesion likely to agree with the diagnosis is an obsolete one, in which no one can predict renewed activity. Auscultation, I think, is much more trustworthy in apex lesions, though the skiagram should always be made, preserved and compared with later ones. The methods of apical roentgenology offer a striking contrast to those followed in gastric, duodenal and gallbladder work.

X-ray examinations are indispensable in the accurate recognition of all chronic diseases of the lung and pleura, and especially bronchiectasis and encysted old pleurisies with or without fibrosis, but without the exploring needle the latter cannot be understood. In these two conditions *x*-ray specialists can learn much from thoracic surgery, and it is to be hoped that all cases suitable be carefully studied before, at, and after operations on lungs and pleurae.

Roentgenology is indispensable in the diagnosis of aneurysms, for some can only be recognized in this way and even those made out by the physical signs can be more completely explained by *x*-ray examinations. Yet even in this field there are sources of error that the mere technician will do well to bear in mind. The heart and pericardium furnish another field deserving careful collaboration between roentgenologists and anatomists. I have seen one of the former make the same mistake that sometimes befalls the physical diagnostician—take a pericardial effusion for enlarged heart, because the cardiohepatic angle was not obliterated, as it is supposed to be with effusion, but is not always.

The great field of dental radiography furnishes many illustrations of the fact that it is still in the stage of development. Experts are too prone to give positive statements of films or plates alone, sometimes missing quite important lesions, then again ordering removal of teeth, a problem purely dental.

Some old errors are certain to be repeated in the interesting field of pneumoperitoneal fluoroscopy and skiagraphy. One can make out organs beautifully; one can detect many small foci of disease on the surface, but histologic features will not be cleared up, so the need of exploration cannot be avoided. The same sorts of mistakes that have been made through relying on examinations of ascitic fluids will be made in this variety of roentgenologic work, if it is depended upon alone.

The great advances in gastro-intestinal fluoroscopy and skiagraphy, intestinal ulcerations and adhesions, and especially diseases of the stomach and duodenum, bile tract and appendix, throw a flood of light on the methods of improving all departments. I have spoken of the need for autopsies in clearing up lung diagnosis. In gastro-intestinal work we have the invaluable cooperation of the surgeon in very many cases, so we owe him, as well as the physiologists who have added so much to the subject, thanks for a great part of the advance, and we should keep in close touch with all operative procedures on *"geröntgt"* patients, in order to have a vivid picture of actual conditions.

Your President has asked me what undergraduates should be taught about *x*-ray work. That is a large and very important question. I will simply tell what we do here without wishing to be understood that we think we have reached finality either in methods or results.

Our students are given demonstrations in the anatomical course showing the use of *x*-rays in embryology, bone development and evidence of age in growing bones. It is used by Dr. Opie in the teaching of pathology. I take the class in the second third of the second year, with a course in physical diagnosis, and use selected plates to show types, especially of the thorax, variations of position of thoracic organs in health and disease; position of stomach and intestines. As the members of the class percuss and auscult each other, and make diagrams of the results, we select a group of various shapes of heart dullness, and various heights of diaphragm, mark out the percussion lines with lead strips and take seven foot plates in the same quiet breathing in which percussion was done. These are placed before the class in the following exercises. If we find anything abnormal in these healthy subjects, such as signs of old pleurisy, valvular lesions, etc. we get plates and demonstrate in the same way. We do not allow the class to use the fluoroscope on account of the number (thirty-five) and the risk of prolonged exposure from overenthusiasm or of waste of time from too brief observations. In this same class we show the skiagrams of patients who have been seen and palpated for pleural friction, thrills or aneurysmal pulsations, of those who have been demonstrated with dullness from pleural effusion, then tapped, with plates taken before and after, and demonstrations of the resonance in the cleared area.

In the third and fourth years we study with the class or groups all the plates of patients seen in out-patient department and wards. Students spend three months each year in each division of Medicine, Surgery and Gynecology-Obstetrics-Pediatrics, see plates of many of the cases under their care, and have an opportunity of seeing fluoroscopic examinations of many lesions such as esophageal stricture, cardiospasm, gastric and duodenal ulcer, gastric carcinoma, colon diseases, including diverticulosis. I should add that we take tuberculosis patients in all stages (in limited numbers) and are able to study the *x*-ray features as thoroughly as possible.

My colleague, Mills, gives a series of demonstrations of diagnostic work in abdominal disease, and he, as well as Dr. Sherwood Moore, offer optional courses in *x*-ray diagnosis and technique.

In other departments equal importance is given to the study of plates and fluoroscopy, the bone and cranial work occupying a very large field.

No practical work with tubes is given, except to individuals with spare time and sufficient preliminary training, or in special courses.

We consider knowledge of *x*-ray evidences of disease essential to the graduate, but think technique and original diagnostic work should be taken up by a course of apprenticeship later on, though it may begin in the interne year. In other words, we think every student must know how to use a laryngoscope and ophthalmoscope, to know the elements of bacteriology and serology, but that not everyone as an undergraduate can learn how to use *x*-rays, or for that matter cystoscopes, bronchoscopes, Wassermann technique and many other matters.

As many of you heard the outline of graduate education by Dr. Louis B. Wilson at the September meeting of the society, and all have probably read it in the December number of the Journal, I need do no more than express my admiration for the course proposed and congratulate those able to follow it.

THE INTENSITY OF SCATTERED X-RAYS IN RADIOGRAPHY*

By R. B. WILSEY

Communication No. 102 from the Research Laboratory, Eastman Kodak Company

ROCHESTER, NEW YORK

SCATTERED radiation is the only type of secondary *x*-rays which is an appreciable factor in medical radiography. The fluorescent or characteristic radiation from the chemical elements of low atomic weight, such as make up the human body, is negligible. Even the fluorescent radiation from most metals when exited by primary rays of the usual radiographic quality (corresponding to a 5 inch spark-gap) is so soft and of such low intensity that it does not noticeably affect a film through the ordinary cardboard holder or paper envelope.

Most of our information about scattered *x*-rays is from the investigations of Crowther, Barkla and his associates, and Hull. In the study of the fundamental laws of the scattering of *x*-rays, their experiments were performed with relatively thin sections of matter, in order to minimize such effects as absorption and re-scattering of the scattered rays. The principal conclusions reached by these investigators on the scattering of *x*-rays by the lighter elements may be summarized as follows:

1. The scattered radiation from an element is independent of its physical state and its chemical combination.
2. All wave-lengths of *x*-rays (within the the range usually employed) are scattered equally; in other words, the hardness of the scattered rays is equal to that of the primary beam.
3. All substances of the class considered scatter *x*-rays equally mass for mass.
4. The scattering is greater in the direction of propagation of the primary beam than in the opposite direction, and it is greater in either of these directions than in directions at right angles to the primary rays.

In the light of these facts, the best advice has been to use diaphragms to reduce the scattered radiation in radiography, the usual procedure being to limit the volume of matter rayed by means of a cone or diaphragm between the tube and the scattering material.

There has been practically no systematic investigation of the behavior of scattered *x*-rays in large volumes of matter. On account of the considerable effect of scattered radiation in reducing contrast and obliterating detail in the radiographs of thick parts, the present investigation was undertaken to study the scattering of *x*-rays from the standpoint of practical radiography. While we may generalize to some extent on the effects of various factors in technique upon scattered radiation, the lack of quantitative data has prevented any effective analysis of the problem. In the present work the problem of scattered radiation has been approached in two ways, first by measurements of the *intensities* of scattered radiation under various conditions, and second by the *effects* of scattered radiation upon contrast and definition in radiographs[1]. The aim has been to determine the relation of the various factors in the radiographic process to scattered radiation; these factors include those under our control, such as tube voltage, filters and diaphragms, as well as those factors which we cannot ordinarily change, such as amount and distribution of the scattering material.

The effects of scattered radiation can be foretold to a considerable extent if we first know the relative amounts of scattered rays and primary focal rays reaching the plate or film. As a rule, we are apt to judge the amount of scattered radiation affecting a radiograph by the contrast. This is not fully justifiable since the contrast depends to a certain extent upon the character of the photographic material used, development conditions, etc. A radiograph can be copied in such a way as to obtain a negative of much greater contrast than the original. Obviously this process does not affect the scattered radiation which was incident upon the original radiograph, although it may overcome the loss of contrast produced by the scattered rays. The method used in the present experiments measured the relative photographic intensities of scattered and focal radiations incident upon the film independently of any contrast effects. The term "photographic intensity" refers to the intensity as evaluated by the photographic material used, as distinguished from the value which might be obtained in recording the radiation by some other means, such as an ionization chamber, a fluorescent screen, or a different photographic material. The evaluation of photographic intensity therefore depends upon the way the photographic surface integrates the intensities of the various wave lengths of radiation incident upon it.

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[1] The data on the effects of scattered radiation will be presented in another paper in the near future.

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14-17, 1920.

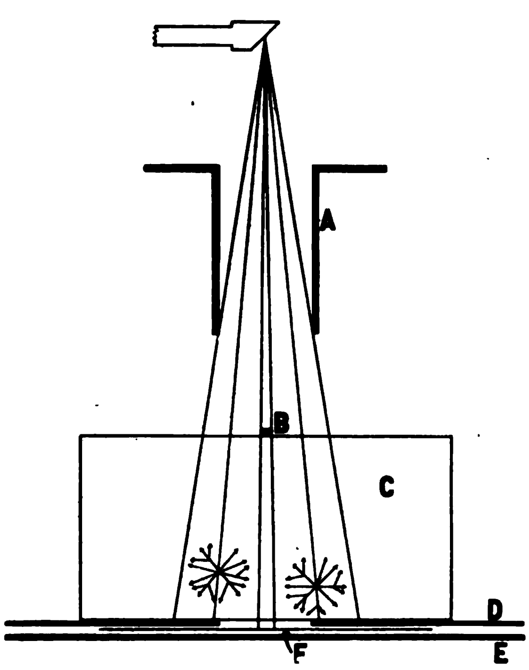

FIG. 1. Diagram showing experimental arrangement for the determination of the ratio of diffuse to total radiation. *A* is a lead cone; *B*, a small lead disk; *C*, the scattering material; *D*, a lead diaphragm between the scattering material and the film; *E*, a sheet of lead beneath the film *F*.

The experimental arrangement is illustrated in Figure 1. A thickness of scattering material C was placed over the film F. A lead disk, B, 5/16 inch in diameter by ¼ inch thick, was centered over the scattering material. The only rays which could fall in the shadow of the lead disk were scattered rays and primary rays from other parts of the target than the focal spot. Both types of radiation will be included in the term *diffuse radiation,* while the primary rays coming from the focal spot will be designated as *focal radiation.* The rays falling outside the shadow of the disk included both the primary rays transmitted by the interposed material and the scattered rays.

A lead diaphragm D of 3 inch aperture and 1/16 inch thickness was placed between the scattering material and the film. This enabled six separate exposures to be made from an 8 x 10 inch sheet of film. The area of material rayed could be limited by a cone or diaphragm placed between the tube and the material.

The experimental procedure was as follows: Keeping the tube voltage and current constant, a series of six exposures was made on a sheet of film, producing on development a series of densities varying from light to moderately heavy. Figure 2 shows a series of exposures made in this way. Each exposed portion of the film consisted of a darkened area surrounding a small circular area of lighter density; the density in the small area was caused by diffuse radiation alone, while the density of the outer area was produced by the total radiation transmitted by scattering material. These densities were measured with a photometer, and curves plotted of density against time of exposure, both for the total radiation reaching the film and the diffuse radiation. From these curves were determined the relative exposures required to produce equal densities by the diffuse radiation and by the total radiation; the relative intensity of diffuse and total radiation was taken at the reciprocal of the ratio of exposures required to produce equal density on the film. For instance, if twenty second's exposure to the total radiation produced a given density and twice that exposure, or forty seconds, was required by the diffuse radiation to give the same density, then the diffuse radiation was half the intensity of the total radiation; in other words, half the radiation reaching the film in this case was diffuse, non-image-forming, radiation.

The value obtained is independent of the contrast or degree of development of the photographic material, provided the characteristics of the material are the same for two radiations being compared. In these experiments no definite difference was observed between the characteristic curves produced by the diffuse radiation and the total radiation.

For most of the work ordinary tap water was used as the scattering material. The density of water and its absorption and scattering characteristics are similar to those of human flesh, making it a very suitable material for the present experiments. The water was contained in an aluminum tank 12 inches square by 10 inches deep. The bottom of the tank was 1/32 inch thick. As will be shown later, the absorption of this thickness of aluminum was too small to affect the results appreciably. Some experiments on scattering were also performed with printer's roller composition, a compound made of organic substances and having a density (ratio of mass to volume) of 1.33. This material is more convenient to handle than water, but its scattering power is somewhat too high to be comparable with human flesh.

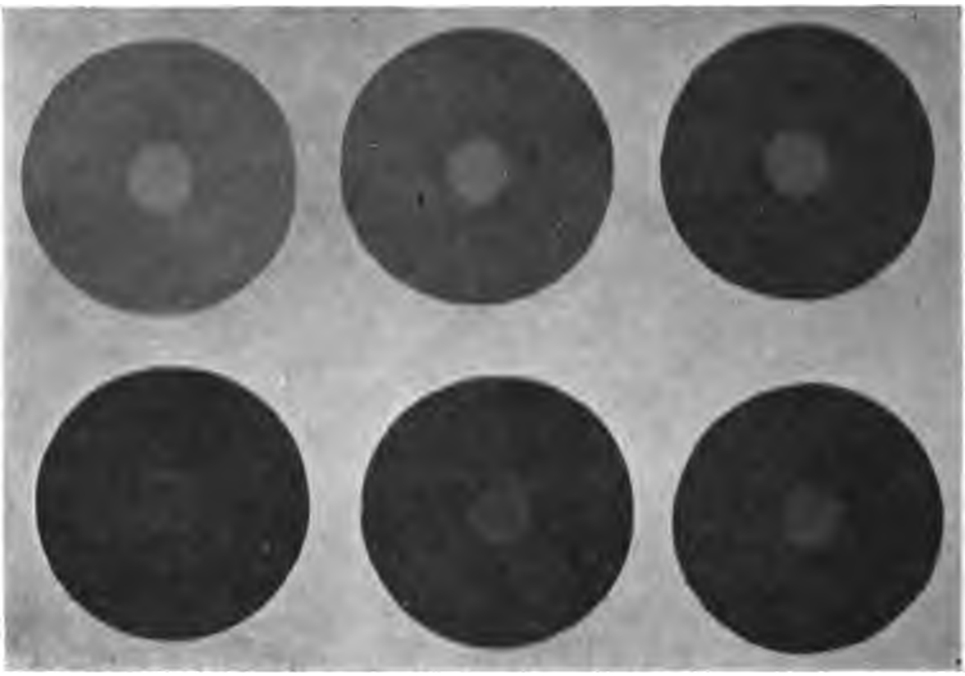

FIG. 2. Illustrating a series of exposures made to determine the ratio of diffuse to total radiation. The lighter density in the center of each exposure was produced by purely diffuse radiation in the shadow of the lead disk; the outer density was produced by the total radiation transmitted by the scattering material.

The spark-gap was measured between dull points, and the tube voltage kept constant during an exposure with the aid of a voltmeter on the primary of the transformer. The Coolidge radiator type tube was used throughout these experiments. The target-film distance was maintained at 20 inches. The tube current was kept constant during each exposure and was adjusted as far as possible so that the desired densities could be obtained in exposure times varying from ten seconds upward. For long exposures the tube current was not allowed to exceed 4.5 milliamperes. Duplitized x-ray film was used as the photographic material; the films were developed in a tank of elon-hydroquinone developer for five minutes at a temperature approximately 65° Fahrenheit; the films were kept in constant irregular motion to insure uniformity of development[2]. As stated previously, the degree of development of the film has no effect upon the values obtained; the chief consideration is that each film receive uniform development over its whole surface. For each set of conditions six or more films were exposed (unless otherwise specified) and the average value obtained of the ratio of the diffuse to the total radiation reaching the film. The effects of diaphragms, thickness of scattering material, tube-voltage and filters (between the scattering material and film) upon the ratio were investigated.

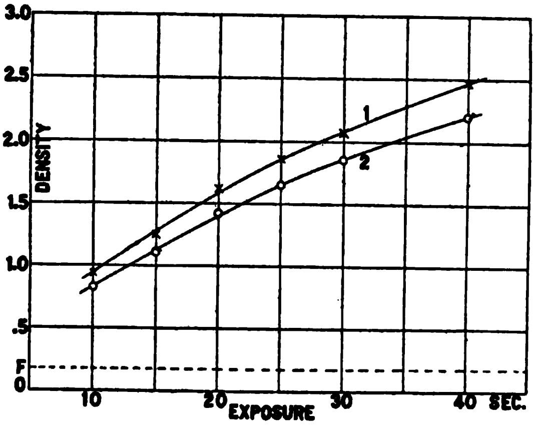

FIG. 3. Curves of density of film plotted against exposure time. Curve 1 is for the total radiation reaching the film, and Curve 2 the diffuse radiation in the shadow of the lead disk. Conditions; 6 inch depth of water (12 x 12 inches) as the scattering material, 20 inch target-film distance, 5 inch spark-gap, 3.5 milliamperes. F represents the fog density, or the density of the unexposed portions of the film.

TABLE I

DATA TAKEN FROM CURVES OF FIGURE 3

Density of Film	*Exposure to Total Radiation in Seconds* E_T	*Exposure to Diffuse Radiation in Seconds* E_D	*Ratio of Exposures* $\frac{E_T}{E_D} = \frac{D}{T}$
1.0	10.7	12.8	.84
1.3	15.4	18.2	.85
1.6	20.2	23.9	.84
1.9	25.9	31.3	.83
2.2	33.2	40.4	.82
		Mean	.84

Figure 3 shows examples of the curves obtained of density plotted against exposure time. The film giving these curves was exposed through six inches of water with the tube running at 5 inch spark-gap and 3.5 milliamperes. The exposures varied from 10 to 40 seconds. The densities of Curve 1 were produced by the total radiation reaching the film, while the densities of Curve 2 were produced by the purely diffuse radiation falling in the shadow of the lead disk. If there were no diffuse radiation, Curve 2 would coincide with the dotted line F representing the fog density, or the density of the unexposed portions of the film. It will be noted, however, that the densities from diffuse radiation are not much less than those produced by the total radiation. At several density values the corresponding exposure times for diffuse and total radiation were read from the curves and their inverse ratios calculated as shown in Table I. The average of these ratios gave the value determined from this film, and the final average was taken from six or more such films. From these particular curves the value of this ratio is .84; in other words under these conditions 84 per cent of the total radiation striking the film is diffuse radiation and 16 per cent is image-forming or focal radiation.[3]

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[2] This precaution is unnecessary in developing ordinary radiographs.

The proportion of diffuse radiation reaching the film was first investigated for various thicknesses of water and different sizes of cones or diaphragms[4] with the tube running at a 5 inch spark-gap. The results are arranged in Table II.

TABLE II

Thickness of Water in Inches	*Diameter of Image in Inches*	*Ratio Diffuse to Total Radiation Observed*	*Ratio Diffuse to Total Radiation from Curves* $\frac{D}{T}$	*Ratio Scattered to Total Radiation* $\frac{S}{T}$	*Exposure Factor*	*Ratio Diffuse to Primary Focal Radiation* $\frac{D}{F}$
2	.56	.12	.12	.08	1.8	.14
	1.30	.25	.23	.20	1.5	.30
	4.0	.43	.43	.41	1.14	.75
	6.25	.50	.50	.48	1.0	1.0
	20.0	.50	.50	.48	1.0	1.0
4	.62	.15	.15	.12	3.0	.18
	1.47	.33	.33	.31	2.4	.49
	4.0	.57	.57	.56	1.5	1.33
	6.25	.68	.68	.67	1.14	2.1
	20.0	.72	.72	.71	1.0	2.6
6	.71	.18	.18	.16	4.9	.22
	1.68	.40	.42	.41	3.5	.72
	4.0	.64	.65	.64	2.1	1.9
	6.25	.77	.77	.76	1.4	3.3
	20.0	.83	.83	.83	1.0	4.9
8	.83	.22	.22	.20	6.7	.28
	1.96	.52	.51	.50	4.2	1.04
	4.0	.72	.72	.71	2.4	2.6
	6.25	.81	.81	.81	1.6	4.3
	20.0	.87	.88	.88	1.00	7.3
10	4.0	.76	.76	.76	3.0	3.2
	6.56	.83	.83	.83	2.1	4.9
	20.0	.92	.92	.92	1.0	11.5

The first column gives the thickness of water x-rayed. The second column gives the diameter of image on the film as determined by the cone or diaphragm used between the tube and the scattering material; this value suffices for the specification of the cone or diaphragm. The dimensions and position of the cone or diaphragm between the tube and the scattering material make no difference as long as the image diameter on the film is kept the same. Therefore with a constant target-film distance of 20 inches, it is unnecessary to describe the cone or diaphragm otherwise than to give the image diameter produced by it. The smaller image sizes were produced by small lead diaphragms supported at the surface of the water, and the corresponding image diameters vary with the thickness of water; the larger sizes were made with cones, and the largest size, 20 inches, was that produced by the opening in lead glass shield around the tube.

The image diameters given have been corrected for the area of the shadow of the small lead disk. In the case of the smallest image size (made with a ½ inch diaphragm) the lead disk was not used; the ratio of diffuse to total radiation was determined by measurements of the densities on the film of the image of the diaphragm opening and the densities (from diffuse radiation) just outside the diaphragmed image.

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[3] The final average for all the films exposed under these conditions was 83%, as shown in Table II.

[4] The efficiency of the Bucky diaphragm principle was not determined in the present experiments, but will be investigated in the near future.

The third column gives the observed ratios of the diffuse to the total radiation. When these are plotted against thickness of water, a number of the values do not fall on a smooth curve. For the succeeding calculations, values taken from the curves were taken as the most probable values and are tabulated in column 4. The scattered radiation is somewhat less than the diffuse radiation, since the latter includes primary radiation from other parts of the target than the focal spot. The small correction for this deducted from the values of column 4 give the ratios of scattered to total radiation as tabulated in column 5. The method of making this correction is described later.

When scattered radiation is lessened by means of a cone or diaphragm, the decreased intensity of the radiation striking the film necessitates a longer exposure. For each thickness of water, the exposure for a 20 inch image is here taken as the ordinary or standard exposure. The factor by which this exposure must be multiplied to produce the same density of film when a cone or diaphragm further limits the scattered radiation is called the "exposure factor"; these factors are calculated from the values of column 5 and are tabulated in column 6. This calculation is based on the fact that the intensity of primary radiation reaching the film is unaffected by the cone or diaphragm; only the scattered radiation is thereby diminished. Let P_{20} represent the primary radiation, S_{20} the scattered radiation, and T_{20} the total radiation reaching the film with an image diameter of 20 inches, and P_X the primary radiation, S_X the scattered radiation, and T_X the total radiation reaching the film where the image diameter is X inches. If the total x-ray intensity reaching the film is diminished in the ratio of $\frac{T_X}{T_{20}}$ the exposure time must be multiplied by the inverse ratio in order to obtain the same density of film; the exposure factor is therefore $\frac{T_{20}}{T_X}$

Now, $T = P + S$, or $P = T - S$
and $P_X = P_{20}$
Then,

$$\frac{T_{20}}{T_X} = \frac{\frac{T_{20}}{P_{20}}}{\frac{T_X}{P_X}} = \frac{\frac{T_{20}}{T_{20} - S_{20}}}{\frac{T_X}{T_X - S_X}} = \frac{1 - \frac{S_X}{T_X}}{1 - \frac{S_{20}}{T_{20}}}$$

By this equation the exposure factors may be computed from the values of $\frac{S}{T}$ tabulated in column 5.

The number which is the true measure of the effect of the diffuse radiation is the ratio of the diffuse radiation to the primary focal radiation. This ration is given in the last column; it is computed by the relation $\frac{D}{F} = \frac{\frac{D}{T}}{1 - \frac{D}{T}}$ where $\frac{D}{F}$ represents the ratio of diffuse to focal radiation, and $\frac{D}{T}$ the ratio of diffuse to total radiation, the values of which are tabulated in column 4. For instance, if the ratio of diffuse to total radiation is .80, the ratio of focal to total radiation is 1 —.80 or .20 and the ratio of diffuse to focal radiation is $\frac{.80}{.20}$ or 4.0.

The values in Table II show the large part played by scattered x-rays in the radiography of the thicker parts of the human body. Under most conditions the diffuse radiation is by far the major portion of the radiation reaching the photographic surface; under conditions similar to those in the radiography of deep parts the intensity of the diffuse radiation is about 4 to 10 times the intensity of the focal radiation. Its marked effect in reducing contrast and definition can readily be appreciated. The elimination of all or a large part of the diffuse radiation should result in a great improvement in the quality and diagnostic value of radiographs. Diffuse radiation is reduced to a relatively small value by diaphragming the image to a very small size, ¾ inch in diameter or less.

This size is too small to be of much use although it might be of occasional value in such work as studying the fine structure of diseased bone tissue.

Figure 4 shows the curves of ratio of diffuse to total radiation plotted against thickness of water (for the various sizes of cones and diaphragms). The observed values are indicated by small circles. Figure 5 gives the curves of ratio of diffuse to focal radiation plotted against thickness of water, showing the increase of the scattering effect with increase in thickness of water. Figure 6 shows this ratio plotted against image diameter for the various thicknesses of water; the number on each curve represents the thickness of water in inches. This set of curves is the most instructive of any of those shown. For each thickness of water, as the image diameter is diminished from 20 inches, the scattering does not much decrease until a certain point is reached; then as the image size is further diminished the scattering decreases quite rapidly. This effect is most noticeable for the smaller thicknesses. In radiographing through 2 inches of water, no decrease in scattering is produced by diaphragming the image to 6¼ inches diameter. The image size where the scattering begins to diminish appreciably is greater for the greater thicknesses of water. In radiographing through 10 inches of water, diaphragming to anything less than 20 inches produces a marked decrease in the scattering effect. The ordinate value unity represents a diffuse radiation of one-half the intensity of the total radiation. The portions of the curves above this value show the large range of conditions where the diffuse rays form the greater portion of the total radiation reaching the film. It is evident that in using a cone or diaphragm to reduce scattered radiation, the smallest size practicable under the circumstances should be employed.

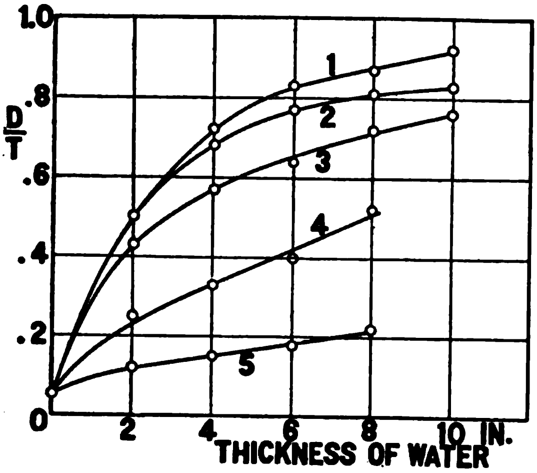

Fig. 4. Curves showing ratio of diffuse to total radiation plotted against thickness of water. Curve 1 is for an image diameter of 20 inches; Curve 2, image diameter of 6.25 inches; Curve 3, image diameter of 4 inches; Curve 4, a diaphragm of 1 3/16 inch diameter at surface of water; Curve 5, a diaphragm of ½ inch in diameter at surface of water.

In order to derive the ratios of scattered to total radiation from the ratios of diffuse to total radiation measured experimentally, it was necessary to determine the proportion of primary radiation reaching the film from other parts of the target than the focal spot.

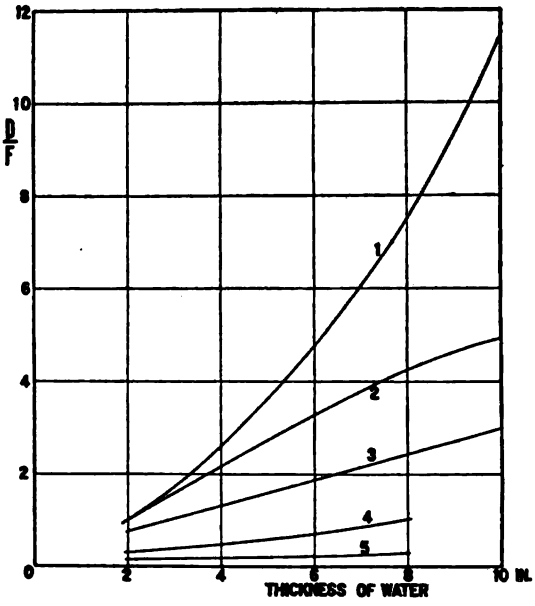

Fig. 5. Curves showing ratio of diffuse to focal radiation plotted against thickness of water. Curve 1 is for an image diameter of 20 inches; Curve 2, image diameter 6¼ inches; Curve 3, image diameter 4 inches, Curve 4, 1 3/16 inch diaphragm at surface of water; Curve 5, ½ inch diaphragm at surface of water.

If in the arrangement shown in Figure 1

the scattering material be omitted, the radiation falling in the shadow of the small lead disk is extra-focal primary radiation. Its ratio to the total radiation was measured by the method already outlined, i. e., by determining the relative exposures required for equal densities of film in the shadow of the lead disk and just outside that shadow. By this method, with no absorbing material between the tube and the film, the radiation from other parts of the target than the focal spot was found to be .053 of the total radiation. This value was found to be about the same for all sizes of cones or diaphragms and for all positions of the small lead disk used in the present experiments. Since the effect of the extra-focal radiation upon the ratios $\frac{D}{T}$ of column 4, Table II, is very small, its precise determination for every set of conditions is unnecessary. The greatest variation in the proportion of extra-focal radiation was produced by the absorbing material between the target and the film. The radiation from the copper of the target is softer than that from the tungsten, and it is therefore absorbed more when matter is introduced between the target and the film. The proportion of extra-focal primary radiation reaching the film when scattering material was inteposed was determined by measuring the relative intensities of radiation reaching the film with the target face turned toward the film and with the target face turned away from the film. By this method with no absorbing material present, the radiation from the back of the target was found to be .041 of the radiation from front of the target. With 4 inches of water this was reduced to .026 or 63 per cent of the value for no absorbing material. With 6 inches of water this ratio was found to be .020 or 49 per cent of the value for no absorbing material. The proportion of extra-focal radiation when the target face is turned toward the film had been found to be .053 with no absorbing material. With 4 inches of water this value should be reduced to 63 per cent of .053 or .033. With 6 inches of water this value becomes 49 per cent of .053 or .026. The determinations for greater thicknesses of water required such long exposures that it was decided not to make them, but rather to use in the computations values extrapolated from the curve of the already observed values. The curve of the ratio of extra-focal primary radiation to total primary radiation reaching the film, plotted against thickness of water, is shown in Figure 7.

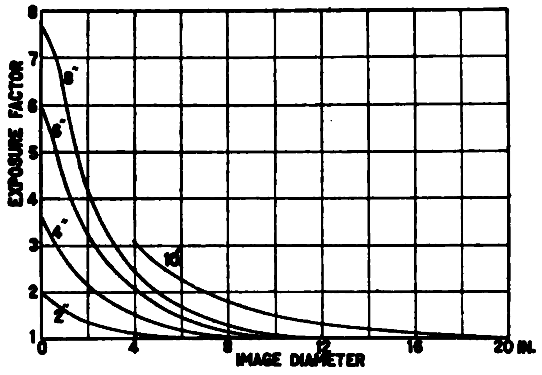

Fig. 6. Curves showing ratio of diffuse to focal radiation plotted against image diameter. The thickness of water is designated on each curve.

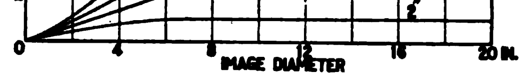

Fig. 7. Curve showing ratio of extra-focal primary radiation to total primary radiation plotted against thickness of water.

It was now required to determine the effect of the extra-focal radiation upon the ratio of diffuse to total radiation. Let P represent the total intensity of the primary radiation reaching the film when a given amount of scattering material is interposed. Let *a* be the fraction of this coming from other parts of the target than the focal spot;

then aP is the intensity of the extra-focal primary radiation and $(1-a)$ P the intensity of the focal radiation. Let S be the scattered radiation, D the total diffuse radiation, and T the total radiation, reaching the film.

Then $D = S + aP, \quad (1)$

and $T = S + P; \quad (2)$

also $T = D + (1 - a)P \quad (3)$

Dividing equation (1) by T, we find that the observed ratio of diffuse to total radiation

$$\frac{D}{T} = \frac{S + aP}{T} \quad (4)$$

Substituting for P its value T — S by equation (2), we obtain

$$\frac{D}{T} = \frac{S + aT - aS}{T} \quad \frac{S(1 - a) + aT}{T}$$

$$= \frac{S}{T}(1 - a) + a \quad (5)$$

Whence

$$\frac{S}{T} = \frac{\frac{D}{T} - a}{1 - a} \quad (6)$$

Thus by this equation the ratio of scattered to total radiation, $\frac{S}{T}$ may be computed from the experimentally determined value of the ratio of diffuse to total radiation, $\frac{D}{T}$. For example, the value of $\frac{D}{T}$ for 4 inches of water and 6.25 inch image diameter is .68 (Column 4, Table II), and the fraction a has the value .033. Then applying equation (6)

$$\frac{S}{T} = \frac{1 - .033}{.68 - .033} = \frac{.647}{.967} = .67$$

the value recorded in Column 5, Table II. The values of $\frac{S}{T}$ are required for the calculations of the exposure factors. It will be noted that in the presence of any considerable amount of scattered radiation, the difference between $\frac{D}{T}$ and $\frac{S}{T}$ is quite small, usually about .01 or .02; under such conditions the extra-focal primary radiation is a negligible portion of the total radiation reaching the film, and it is quite small (5 per cent or less) when there is no scattered radiation.

The curves in Figure 8 show the variations of exposure factor with image diameter; the thicknesses of water are indicated by the numbers on the curves. The exposure factors for zero image size are the values computed for the case where all the diffuse radiation is removed.

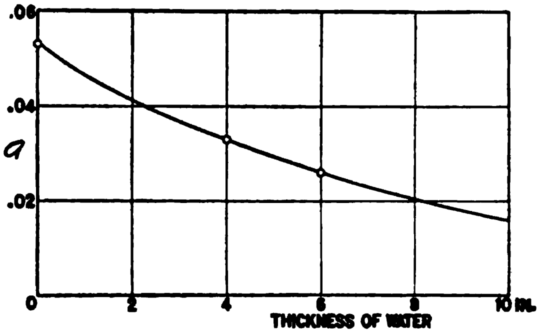

FIG. 8. Curves of exposure factor plotted against image diameter. The thickness of water is designated on each curve.

It may be noted in this connection that the efficiency of a diaphragm under any

TABLE III

Thickness of Composition in Inches	*Diameter of Image in Inches*	*Ratio Diffuse to Total Radiation*	*Ratio Diffuse to Primary Focal Radiation*
2	1.30	.30	.43
	4.0	.47	.89
	20.0	.55	1.22
4	1.47	.35	.54
	4.0	.66	1.9
	20.0	.76	3.2
6	1.68	.46	.85
	4.0	.73	2.7
	20.0	.88	7.3

conditions can be estimated roughly from the exposure factor. For instance, if a given diaphragm necessitates a doubling of the exposure to produce the same density, the total *x*-ray intensity has been halved and more than half of the diffuse radiation has been removed.

With printers' roller composition as the scattering material, the results recorded in Table III were obtained. Most of these values are the mean of three or four determinations and are therefore not quite so reliable as the results obtained with water. For equal thicknesses, the printers' roller composition scatters more than water; the proportion of diffuse radiation reaching the film is roughly the same for equal masses of water and roller composition rayed, i. e., for equal image sizes, a given thickness of roller composition produces about the same proportion of scattered radiation on the film as a one-third greater thickness of water (density of composition being 1.33).

The effect of tube voltage upon the proportion of diffuse radiation striking the film was studied for a range of spark-gaps from 3 to 9 inches, radiographing through a thickness of 6 inches of water. Table IV shows a summary of the results obtained. The effect of scattered rays upon the film was found to increase slowly with the spark gap. Thus the lowering of contrast produced by increasing the penetration is due in part to the increased scattering as well as the lowered absorption of the image-forming rays.

TABLE IV

EFFECT OF TUBE VOLTAGE UPON PROPORTION OF DIFFUSE RADIATION IN RADIOGRAPHING THROUGH SIX INCHES OF WATER

Spark Gap in Inches	*Ratio Diffuse to Total Radiation*	*Ratio Diffuse to Primary Focal Radiation*
3	.81	4.3
4	.82	4.6
5	.83	4.9
5½	.85	5.7
6	.85	5.7
7	.85	5.7
9	.87	6.7

These data indicate that the scattered radiation affecting the film is slightly harder than the primary radiation, since an increase in the proportion of hard rays in the primary beam increases the proportion of scattered rays reaching the film. This is to be expected from the fact that the scattered rays have traversed a longer distance in the material than the primary rays, and have suffered a corresponding greater filtering action; the soft scattered rays have been thereby absorbed more than the soft primary rays before reaching the film, leaving a greater proportion of hard rays in the scattered radiation.

TABLE V

Filter	*Ratio Diffuse to Total Radiation*	*Ratio Diffuse to Primary Focal Radiation*
None	.83	4.9
1/16 inch aluminum	.82	4.6
1/8 inch aluminum	.80	4.0
.001 inch lead foil	.79	3.8
Thin intensifying screen	.79	3.8

Contrary to this conclusion, it is sometimes claimed that the so-called "soft secondary radiation" can be screened out by a filter placed between the subject and the plate, with the effect of noticeably improving contrast in the radiograph. This view is evidently due to an impression that the secondary radiation from the human body is largely fluorescent radiation. To test out this point, the proportions of diffuse radiation affecting the film were determined with several types of filters placed between the scattering material and the film, with the tube running at a 5 inch spark-gap. Table V gives the results obtained in radiographing through six inches of water. The filters specified are in addition to the 1/32 inch of aluminum of the bottom of the tank. This thickness of aluminum evidently has some slight influence upon the scattered rays, but its effect is certainly less than the errors of observation. For present purposes, it may be considered part of the scattering material. The various filters are seen to diminish slightly the effect of scattered radiation upon the film; the action of the lead foil and the intensifying screen filters is slightly greater than that for aluminum. The effect of the filters may perhaps be ascribed to the fact that scattered rays making small angles with the film must traverse a greater thickness of filter. While a filter may tend to increase contrast slightly by reducing the proportion of scattered rays, its action in filtering out the softer primary rays tends to reduce the contrast. An experiment to determine the effect upon contrast of a lead foil filter between the scattering material and the film showed that the filter produced no change in the contrast.

SUMMARY

The relative photographic intensities of diffuse and primary focal radiation reaching the film were measured under a variety of conditions, showing the effects of thickness of scattering material, sizes of cones or diaphragms between the tube and the scattering material, tube voltage, and filters placed between the scattering material and the film.

Under conditions similar to those in the radiography of thick parts, the scattered radiation reaching the film is roughly from four to ten times the intensity of the primary focal radiation. The intensity of the scattered radiation is small when the thickness of the scattering material is small or when the x-ray image is diaphragmed to a very small size. Data on the effects of thickness of scattering material and image size are given in Table II, and are shown graphically in Figures 4, 5, and 6.

The removal of any scattered radiation necessitates an increase in exposure, to compensate for the loss in total *x*-ray intensity. The exposure factors corresponding to the various thicknesses of water and image sizes are given in Column 6 of Table II, and are shown graphically in Figure 8.

The ratio of diffuse to primary radiation reaching the film was found to increase slightly as the tube voltage was increased.

Filters placed between the scattering material and the film diminish slightly the proportion of diffuse radiation; the filters are of no practical value, however, inasmuch as they do not improve radiographic contrast.

REMARKS ON THE MEASUREMENTS OF SCATTERED RADIATION

By MILLARD B. HODGSON

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THE application of roentgenology of the figures in Mr. Wilsey's paper on scattered *x*-rays promises most valuable results, for the writer believes that this is one of the faw contributions of quantitative measurements of scattered *x*-rays that can be directly applied in practical work.

A number of physicists—Barkla, Hull and

others— have derived physical laws governing the absorption and scattering of *x*-rays by matter, but such figures are exceedingly difficult to apply in roentgenology. Mr. Wilsey's results, on the other hand, may be applied to such problems as radiography and therapy, for the empirical formulae derived contain only those factors that exist in these phases of *x*-ray science. For example, not only can it be seen that, as the diphragm aperture is reduced, the volume of scattered radiation reaching the film is reduced, but the proportional reduction of scatter may be computed directly and the necessary change in exposure time compensated for.

To illustrate: A kidney negative is taken at 25 inches target-film distance, using a diaphragm that covers a 20 inch circle at the film. Let us assume that eight inches of tissue are passed through. The result is a gray, foggy negative with very little detail, for the effect of the image-forming rays has been neutralized by the general fog produced by the scattered rays.

A study of Mr. Wilsey's charts shows that under such conditions the scattered radiation reaching the film has a value equal to 88 per cent of the effective radiation striking it. That is, only 12 per cent of the exposure is image-forming—the rest is obscuring detail.

Substituting a diaphragm that reduces the circle of illumination to 4 inches in diameter, we see that the effect is to reduce the scattered radiation from 88 to 71 per cent, with a proportional increase in the effectiveness of the image-forming rays.

The increase in exposure time necessary to compensate for the loss in total radiation is also given in the tables. For this theoretical case it is necessary to multiply the exposure by 2.4.

It is well this latter fact in mind in work with the Potter-Bucky diaphragm, for the reduction in scattered radiation is analogous to the foregoing. In the average type of Potter-Bucky diaphragm on the market at present the time factor is about 3 or 4. In fact, unless such a diaphragm does have a factor of this order, it would be of very low efficiency, for it would mean that there was very little reduction in the volume of scattered radiation striking the film.

This time increase makes it desirable in a great many cases to use intensifying screens, and Mr. Wilsey's data on the most effective use of these should be studied.

The method used in the paper in question offers a simple means of testing other methods of diaphragming, for all the apparatus necessary is a small cylinder of lead and dental films; at least for a qualitative estimate.

It seems that further applications of these results should be in the field of therapy, for here, obviously, the important thing to know is how much radiation is reaching each cubic centimeter of tissue, and it is evident that this may be computed, at least approximately, from the figures given; certainly with more accuracy than assuming a straight logarithmic absorption law or attempting to deduce from physical measurements of absorption coefficients.

In all such applications it should be borne in mind, however, that the improvement in quality of the image obtained is of such an order of magnitude that errors in technique, especially in the dark room in the case of making negatives, might easily obscure it; therefore the more urgent is the need of standardization in technique, for obviously it would be of little use to remove an obscuring fog by diaphragming and later introduce as dense a fog or a heavier by improper development.

THE BUCKY DIAPHRAGM*

By H. W. VAN ALLEN, M.D.

SPRINGFIELD, MASSACHUSETTS

ONE of the most successful roentgenologists recently said that the moving Bucky diaphragm is the greatest advance in our science since the advent of the Coolidge tube. Great credit is to be given to Dr. Hollis Potter of Chicago for the development of the present status of the method of application of the idea introduced by Bucky of Germany. The original diaphragm produced a radiograph covered by lines running in both directions, the result appearing as though viewed through a grating, and was not a practical procedure. Dr. Potter's method of moving the grid during the exposure has given us a radiograph that is not only practical in its results but startling in its efficiency.

The few moments I shall speak to you I will divide in three portions:

First. A description of the principles of the diaphragm;

Second. The mechanical devices that aid in making a diaphragm satisfactory, and

Third. Some points in the use of the instrument that have been of aid to me.

I presume most of you know the principles involved in the Bucky diaphragm, but I am equally certain a few do not, so I will ask those in the first class to bear with me during a brief description.

When the roentgen ray is passed through resisting substances, secondary rays are given off by this substance. These rays go in all directions. Their excursion is short, but they come from all directions and are more in quantity than the primary ray. These are the rays that fog our plate, making them hazy through the thicker parts of the body, and produce a limit to our ability to examine successfully very large persons. The whole purpose of the Bucky diaphragm is to cut off or strain out as it were the major part of these rays and leave the direct rays unchanged. Probably I can illustrate this in the quickest manner by demonstrating with two charts similar to those published by several authors.

The whole function of the apparatus is to prevent the secondary or fogging rays from striking the plate. Their angle is such that they cannot pass down through the narrow spaces between the lead strips, but striking the lead are prevented from reaching the plate, while the primary ray meets with no such interference and a plate results practically clear from fog.

As to the mechanical perfection of the diaphragm many things are necessary for success. Naturally, one thinks first of the grid. It must be strong and yet light in weight. This we accomplished by making the frame of huron metal—as strong as steel and as light as aluminum. The wood strips of which the grid itself is made up must withstand weather conditions. All wood swells and shrinks with atmospheric changes. Springs are placed at each end, which keep the slats pressed together under all circumstances. An open question is the placing of the lead strips. We experimented with various models and got the best results with about six strips to the inch of three-quarter inch thickness. When the lead strips are closer together the actual amount of lead becomes a factor in making the exposure longer. It is self-evident that the width of the strips does not retard the ray but only the thickness of the lead, so twice as many strips produce twice as much cutting off of the direct ray. The lead used was one half of one hundredth of an inch in thickness. It is also manifest that the wider the strips the more of the secondary rays are cut off. But after a little another disadvantage comes in; that is, the increasing distance between the patient and the plate. Up to three quarters of an inch there seemed to be no difference; beyond this there came distortion. The lead strips should go entirely through the grid, as any other method only increases the patient-plate distances, which is one of the defects of this method of examination. Hollowing out the strips in the center of the sides makes them pinch only on the edges. The wood strips must be narrower on one edge to insure perfect direction of the lead strips toward the central point 25 inches away or the focal point of the tube. The motion of the grid must be uniform. We tried several methods and found two springs better than one, as any friction in one was replaced by the action of the other. A grid should move in any position with equal ease. It is important not only to be able to make the exposure with the patient lying on the diaphragm but also with the patient standing and the diaphragm at his back for sacro-iliac joints. Again, if the diaphragm will work in that position it can be placed at the side of the patient and obtain beautiful radiographs in pneumoperitoneum. Ball-bearing rollers on each side a "V" shaped projection on the grid insure this result. The check to regulate and make the speed uniform is the commonly used principle of a fluid passing through an opening in a piston head. A very satisfactory arrangement was made whereby this valve can be regulated by turning the piston rod. This made necessary only a single rod, projecting from the diaphragm, for setting and regulating the speed. Also it was found that this same valve, by means of a retaining spring, could be used for the return of the fluid, which obviated the necessity of a by-pass. The next essentials were placing and holding the plate. This is easy when the diaphragm is flat, but more difficult in the vertical position. Not only this, but the plate must be held in any place under the grid, and for stereoscopic work must be replaced

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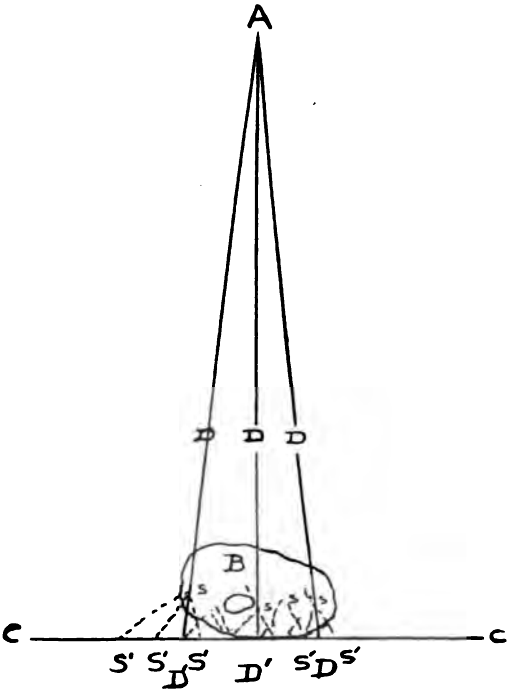
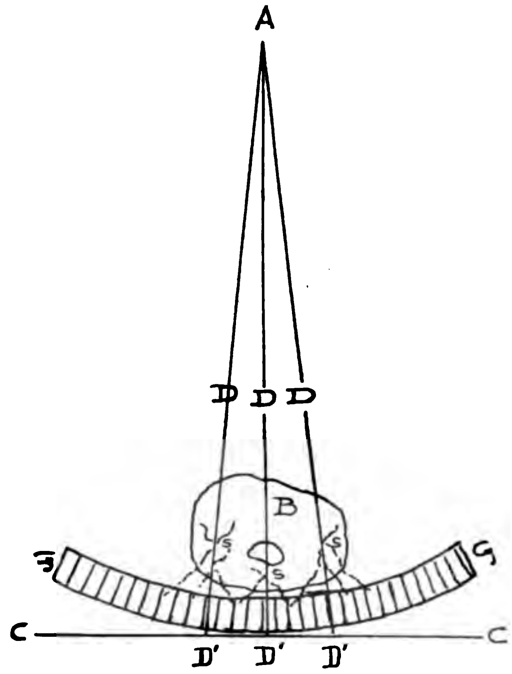
*Read at the Midwinter Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., January 28, 29, 1921.





A = focal point.
B = object to be radiographed.
C = plate.
D = primary ray.
S = secondary ray.
S'= points where the secondary ray strikes the plate.
D'= points where primary ray strikes the plate.
G = grid composed of lead strips supported by intervening wood strips.

in exactly the same position again. A removable pan with lugs accomplished this for us.

Many minor things come to one's mind when working with a new instrument of this kind, as a method of centering the tube, a bell for notifying the operator when the motion of the grid is about over, and handles for ease of placing the diaphragm in position. Some method of stabilizing and compressing the patient is of great value, especially in the upright position.

As to some of the practical points in working with this diaphragm, I am most often asked about the time of exposure. A great deal more than 50 per cent of the photo-chemical effect on the radiographic plate is produced by secondary radiation. Therefore the better the Bucky diaphragm the longer will be the exposure to produce a given amount of darkness on the plate. The more secondary or harmful rays that are cut out the more primary rays will be needed. In actual practice however the time of exposure is not greatly lengthened, as with no more fear of the large amount of secondary rays set up by hard primary rays, longer spark-gap becomes a distinct advantage in penetrating the head and torso of large patients. This is particularly true in the case of those of us who have been using short spark-gaps in our work. Those already using long spark, of course, will of necessity increase the time of exposure when using the diaphragm. The larger the patient the harder the ray required and the more secondary rays produced. These are cut off by the diaphragm, so this makes it possible to say, relatively speaking, the larger the patient the better the plate.

When is it best to use a diaphragm? On all thick parts. When, however, we get down to about three inches of flesh the advantages of the diaphragm are offset by the distance of the patient from the plate and it is no longer of use.

Must the tube be just 25 inches from the plate? No, but placing the tube nearer or farther away causes the direct ray to strike the lead strips not exactly on edge but makes the shadow of the strips wider and this increases the obstruction and length of exposure, which in the case of more than 25 inches added to the distant effect multiplies rapidly. The upright position becomes very valuable in showing ptosis of organs, as the stomach, kidney, etc.; also luxation of the sacro-iliac joint and fifth lumbar vertebra. Side-to-side plates become of value when taken with the added clearness obtained by this method.

A very practical caution I wish to call to your attention is the danger of a burn. These patients are usually large. Were it not for the 25 inches required by the grid one would naturally increase the distance. By not doing so the skin target is quite short. Some defect in the technique may have caused you to get a corresponding defect in the plate. Care must be used not to get an erythema skin dose by repeated exposures.

The grid must be in motion during the entire exposure; the least variation from this rule will give undesirable lines. If for any reason it seems desirable several excursions of the grid may be made for a single radiograph.

I have of late been using a curved cassette with considerable advantage. The curve is the same as that of the grid. In this way all parts of the film are equally distanced from the focal spot and receive equal energy. Each ray strikes the plate at right angles and consequently there is no distortion, and the fuzzy appearance, so common in objects distant from the plate, is obviated. It is also evident that a film curved in this way will cover more of the cone of rays coming from the focal spot than the same plate straight at the distance of the center of the cone.

In conclusion I submit that the Potter-Bucky diaphragm has come to stay as a great aid to roentgenologists. Its final form may be quite different, but the principle is permanent.

SOME ACCESSORIES TO THE POTTER-BUCKY DIAPHRAGM

By DAVID RALPH BOWEN, M.D.

Roentgenologist, Pennsylvania Hospital

PHILADELPHIA, PENNSYLVANIA

ESTIMATES of the value of the Potter-Bucky diaphragm as an advance in roentgenography will, doubtless, vary considerably among roentgenologists. But among those who have mastered its technique, we are sure these estimates will all be high. It is hardly conceivable, for the present, that one who has learned to use this device successfully will be content to do without it.

There are, however, serious practical objections to the apparatus as at present delivered by the various makers. The equipment used by Dr. Potter, in which the diaphragm is adjustable under a canvas stretcher on which the patient reclines, is ideal; but very few have the discarded apparatus which Dr. Potter utilized in his office, and to construct such an apparatus *de novo* entails an expense which many will wish to avoid.

The apparatus here described has proven practical. It obviates all necessity of handling the heavy and somewhat unwieldy apparatus and since we have had it we notice an inclination to increase, rather than decrease, the number of cases in which we use it.

It consists primarily of a simple wooden table constructed at the Pennsylvania Hospital by the house carpenter. The top of the table is made to conform to the curve of the diaphragm, from which it extends two feet on one end and three feet on the other, making a table practically seven feet long, with a recess into which the diaphragm sets so as to be flush with this curved top. In use, a folded bed-sheet is always laid lengthwise of of the entire table and upon this the patient is placed. Even with patients weighing two hundred pounds and over it is not difficult to shift them lengthwise of the table to any desired point by pulling on one or the other end of the sheet. If the top of the table is properly polished this maneuver will be found surprisingly easy; and it is believed that the centering can actually be done in less time than by any of the various mechanisms which might be suggested for the purpose.

Having proceeded this far it becomes desirable to center the tube over the diaphragm after the patient is in place. This is accomplished by a device which we may call a bridge, illustrated in the cut at A. By appropriate marks on either side of the diaphragm, this bridge is readily placed so that a hole through the top of it is directly perpendicular to the top of the diaphragm, and twelve inches above it. By means of a plumb-bob, illustrated at B and elsewhere described[1], the focus spot of the tube is centered directly over this mark on the bridge and thirteen inches above it. If a single exposure is to be made, the tube-stand is fastened at this point and both the bridge and plumb-bob are removed. Stereoscopic exposures are accomplished by dividing the stereoscopic shift,

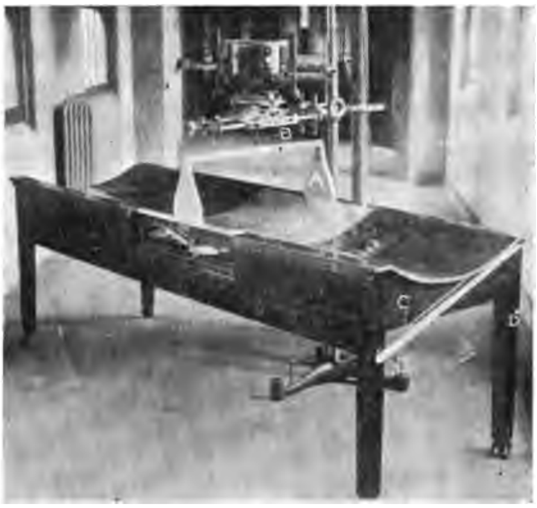


Fig. 1. Showing table described with the diaphragm, bridge and tube in position.

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[1] *Am. J. Roentgenol.*, February, 1918, V, 60.

half toward the head and half toward the feet, from this center point. (Because of difficulty in lighting, a tube-stand has been used in the accompanying illustration which does not permit shifting in this direction.)

It is vitally important, in using this diaphragm, that the operator should know, all the time, just what proportion of the excursion of the diaphragm has been accomplished. A bell which rings near the end of the exposure is of doubtful utility and frequently disturbs the patient, when such disturbance is least desired. We have adopted a signal device, illustrated at C, one end of which is connected by a cord with the moving member of the diaphragm. During the excursion, the end of this pointer travels from the high point at which it is illustrated to the white spot at D. This arrangement permits constant visibility of the excursion in the position in which we work. It could, of course, be arranged at either end or even above the table.

These suggestions are offered as having greatly increased our efficiency in the use of this instrument and as, perhaps, being adaptable by variations to many other laboratories. Dr. Manges has, for instance, found it possible at the Jefferson Hospital to have both table and tube-stand in a fixed position, so that it is necessary only to center the patient on the table.

Perhaps no one factor has caused so much disappointment in the use of the Potter-Bucky diaphragm as the lack of contact of the film with double intensifying screens. We have found that a set of six wooden wedges, forced under the ends of the three springs on the back of the cassette, has almost eliminated this trouble. Such a proceedure is crude, of course, but, pending the time when cassettes which really force contact between film and screen over the entire surface are obtainable, we believe that this maneuver will more than repay the little extra effort which it entails.

DISCUSSION OF DR. J. H. ULLMANN'S PAPER

"Practical Application of the Sphere Gap to Roentgenotherapy"

(Published in the April Issue)

Dr. J. G. Van Zwaluwenburg. I should like to ask Dr. Ullmann if the error does not become progressively greater as you increase the filtration, and whether minor differences in penetration do not produce disproportionately large fluctuations in the quantity of the emergent ray, because of the relatively greater absorption of the softer ray compared with the harder ray. This might have a very important influence in our determination of the standard erythema dose for the individual machine and "set up."

Dr. Hollis E. Potter. First, Dr. Ullmann has shown that there is a discrepancy between supposed and actual voltage of as high as 35 or 40 per cent. This discrepancy is enough to account for the difference between burns and under-dosage.

Second, peak voltage is one of the most important factors in determining the dosage, since it is one of the two factors that vary according to the square.

It is accepted among engineers that the sphere gap is the one best way to measure the voltage of high tension currents, and it is about the only way to standardize a given machine so that it can be made to duplicate results obtained on other apparatus.

It is to be hoped that the manufacturers of apparatus to be used in therapy will provide suitable sets of sphere gaps that can be used by therapists. It is not for routine readings for the occasional verification of their voltmeters.

Dr. H. J. Ullmann. I spoke of using 6.25 or 12.50 cm. spheres because one can get tables showing breakdown voltage for these sizes. I used a 12.50 cm. sphere for this work (12.50 cm. is about 5 inches) as it is the most convenient size for the range of voltage that we have to measure. My apparatus will go to about 180 kilovolts effective before it reaches the limit of the dimensions laid down as a standard.

For accurate work the longest gap should not be greater than the diameter of the spheres but in practice a gap not more than three times the radius may be used. The sphere diameter should not vary more than 00.1 per cent. or the curvature more than 1 per cent from a true sphere. The spheres should be at least twice the gap setting from surroundings and the shanks not greater than one-fifth the sphere diameter.

In regard to filtration I have some figures here based on the work of Dr. Hall of Schenectady, published in the *Proceedings American Institute Electrical Engineers.* Approximately 50 per cent of all the rays passing through 5 mm. of aluminum at 90 KV effective are of the very hard order and at 80 KV the proportion is 4 per cent lower, i. e., 46 per cent. Also according to Dr. Hall's curve if the volume of ray of about 0.2 angström in length is 60 at 80 KV, it will be 100 at 90.

In regard to the question of motors in direct current machines these tests, with one exception, were all made on alternating current outfits. There is no variation in voltage readings at different cycles within the commercial range. I do not know if the readings would be affected by variations above or below these.

I would like to ask Mr. Darnell to tell us if there would be a variation under conditions liable to be met with in our work.

MR. DARNELL. I am not sure; it depends upon circumstances. It is very likely a change in speed on machine would change the speed of all waves, and point-gap machines differ. It is very likely the sphere gaps between the machines are equal—you might say so far as we know. It is the heat of wave which is important so far as therapy is concerned.

MR. ANTE. The diameter of the sphere is the exact diameter of the spark gap.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

H. M. Imboden, M. D., *Editor* · Paul B. Hoeber, *Publisher*

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY

WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921

Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

WASHINGTON MEETING

The Twenty-second Annual Meeting of The American Roentgen Ray Society will be held in Washington, September 27, 28, 29 and 30, 1921. Headquarters, meetings and exhibits will be at the Hotel Washington, Pennsylvania Avenue, opposite the Treasury.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of The American Roenrten Ray Society. Mr. A. Gumpert, Manager of the New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him.

The hotel rates are as follows:

Hotel Washington, every room having private bath with shower, tub and running ice water (European plan only):

	Per day
Single rooms	$5.00 to $7.00
Double rooms (double bed)	8.00
Double rooms (twin beds)	10.00 to 12.00

The New Ebbitt (European plan only):

	Per day
Single room without bath	$2.50
Single room with bath	4.00
Double room without bath, each person	$2.50
Double room with bath, each person	3.50

Also a number of large suites, both with and without bath, which will comfortably accommodate upwards of four persons. On these suites they would make a rate of $3.00 per day each person, with bath, or $2.00 per day each person without bath.

For information regarding the program, those wishing to read papers or to show slides at the meeting should communicate direct with the President, Dr. A. C. Christie, 1621 Connecticut Avenue, N. W., Washington, D. C.

For information regarding commercial exhibits and other business matters connected with the meeting, address the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

It is hoped to arrange for special trains and cars from various sections. Details regarding this will be announced later.

PRELIMINARY ANNOUNCEMENTS

Dr. A. C. Christie, President of the Society, announces that plans for the program of the Annual Meeting of the Society next fall are now well under way. Dr. Réné Ledoux-Lebard will give the Caldwell Lecture on the subject of "Deep Roentgen Therapy." It is planned to give a much larger place on the program to papers on therapy than has hitherto been done. The plan is to hold the meeting for four days, giving the entire first day to papers on therapy and to have the papers on physics during the forenoon of the second day. This will enable those who are interested only in therapy to leave about the middle of the second day, while those interested only in roentgen diagnosis would not feel it necessary to attend until the beginning of the second day. Those interested in both diagnosis and therapy would probably wish to be present the entire four days.

It is believed that this plan will make the meeting of interest to a much larger number of men. It is requested that those who have papers to present at the meeting communicate with the President of the Society at as early a date as possible.

X-RAY WORK FROM THE VIEWPOINT OF AN INTERNIST

The address by Dr. George Dock before the Central Section of The American Roentgen Ray Society is of more than passing interest. It is an appraisement, a critique, and an appeal. The roentgenologist whose medical training fits him to respond to this address will find therein a powerful incentive not merely to do better work but to do the best work. The words carry unusual weight because they were uttered by the one internist of the English speaking world upon whose shoulders has fallen the mantle of William Osler.

Dr. Dock's interest in x-ray work began with Roentgen's discovery. He watched it at first-hand abroad and at home. On his invitation the writer gave the first talk on the x-ray examination of the chest delivered at a great University where for many years he held the chair of medicine. It was due to his influence that the same University obtained its first appropriation of funds for an x-ray installment. His interest in this revolutionary means of diagnosis has expanded with its development, although he has never himself undertaken the technical part of the work.

But he has never ceased to be the skillful and cultured internist. The traditions of the great masters are no less dear to him now because a new science of diagnosis is being written. The stethoscope, the microscope and the test tube are still no less important because of the revelations of the tube and film. The fine art of taking histories and of making the physical examination is now, no less than in the days of Laënnec, the foundation of the diagnostics of internal medicine.

These ideals of the internist he would plant in the minds of the roentgenologist. The search for the pathognomonic sign, like the search for the philosopher's stone, is futile although strangely fertile in unexpected fruit. The work of diagnosis is not shortened by the discovery of new methods. It is amplified and more accurate, but yet in need as much as ever—perhaps more than ever—of the correlating power which comes only from a complete knowledge of the patient. The roentgenologist must refrain, therefore, from issuing diagnoses upon x-ray premises but give instead roentgen interpretations.

Doctor Dock's address is not sugar-coated. His criticisms are sharp and basic. His acidulous remarks are destructive of inferior methods but preservative of the best. However perfect may become x-ray technique and however skillful the roentgenologist, yet in the accumulated experience and achievement of pre-roentgen times lies a body of diagnostic methods which the medical world will never willingly let die.

However much we may admire the vigor, sanity and insight displayed by Dr. Dock we cannot but take issue with him over at least one point. This is the statement that the roentgenologist has never satisfactorily demonstrated his reasons for deciding upon the activity of a tuberculous lesion in the lung from a single examination. If he had said that the activity or quiescence of such a lesion cannot always be decided by a single examination we would unhesitatingly agree. In fact in a previous editorial in the Journal we emphasized the difficulties and dangers of diagnosticating activity from single x-ray examinations and urged the use of serial plates. But we believe that the pages of the Journal and the works of many roentgenologists without regard to nationality have clearly defined the distinctive attribute of the active pulmonary lesion when found on the x-ray plate. Unfortunately it is not present in all stages of activity or in all types of pulmonary tuberculosis. But when found it surpasses all other clinical signs in directness and simplicity. It is merely the nebulous, borderless character of the shadow of activity. Form and distribution may also be at times decisive factors, but it is the nebula which marks the focus in active evolution, the final end of which is the smaller dense calcification of quiescence.

The nebulous quality of the shadow depends upon the fact that activity means inflammation and inflammation means increased blood, serum and leucocytes in the lung tissue and these in turn mean density, The nebula may be parenchymatous or lymphatic or it may be seen as a halo about a calcified focus not yet wholly quiescent. Classifications still vary, but by lymphatic we mean a line or stalk of nebulous density running to the hilum from a small calcified particle well out in the lung field. In some cases scores of these radiation nebulous drainage lines may be traced, each one starting from a calcified particle about which is a soft halo. These may be seen best on stereoscopic films using double screens, the briefest possible exposure with a soft tube, and a long distance between tube and patient.

It may also be asserted and defended that good *x*-ray plates are always right and that only the interpretation is wrong. If a "large pneumothorax" or a "fairly extensive tuberculosis" is missed by the roentgenologist it is the man and not the method that is to blame. We cannot but believe that any pulmonary lesion which brings about changes in density is susceptible of *x*-ray demonstration.

The limits of an editorial allow us to be suggestive merely and we leave to other and more capable hands the full exposition of these and other points which Dr. Dock flings out as a challenge.We need the stimulus of such handling. We regret that he let slip the opportunity for good-natured but invigorating sarcasm regarding the roentgen diagnosis of gallstones. We are satisfied, however, that he has left few fallacies unprodded so far as the roentgen diagnosis of chest lesions is concerned.

There are two sides to every question. We enthusiastically agree with Dr. Dock that *x*-ray interpretation is greatly assisted by clinical data. But the converse is doubly true. Not only are clinical findings frequently reinterpreted by *x*-ray means but the internist himself has been trained to a skill formerly unattainable in thoracic diagnosis by the repeated disclosures of plate and screen.

In the last analysis the plate and screen are but the added resources of the internist. The thermometer, the stethoscope and the whole clinical laboratory were at first fought and disciplined before they were adopted as legitimate members of the family. We have reached the stage of being disciplined. May we not turn the tables and adopt the internist as a legitimate roentgenologist?

A. W. Crane.

EXTERNESHIPS AT MOUNT SINAI

There has been established at the Mount Sinai Hospital, New York City, a system of externeships in the X-Ray Department. There are to be two externes, each serving one year, one beginning February 1st and the other August 1st. The next appointment begins on August 1st, 1921.

OBITUARY NOTICE

The announcement has just been received of the death of Dr. Heinrich Ernst Albers-Schönberg, of Hamburg, an Honorary Member of The American Roentgen Ray Society. Dr. Albers-Schönberg died on June 4th at Allgemeines Krankenhaus St. Georg, Hamburg, from pneumonia. He was in his fifty-seventh year. An obituary will be published in a later issue of the Journal.

BOOK REVIEWS

SURGERY, ITS PRINCIPLES AND PRACTICE. Edited by William Williams Keen, M.D., L.L.D. 855 pages, 359 illustrations, 17 of them in colors. W. B. Saunders Company, Philadelphia.

This volume of Keen's Surgery is one of two volumes designed to complete this standard work on surgery up to the year 1919. Dr. Keen states in the preface that "these volumes do not only record the achievements of surgery from 1914 to 1919. They also fulfill a second purpose I have had in view, viz.; they make available for the surgery of peace the lessons taught us during the war."

Some of the chapter, such as those on "Inflammation" and "Syphilis," are supplementary to chapters in previous volumes. The high standing of the authors of these chapters is sufficient guarantee of their excellence.

A large part of the volume deals with war surgery, either directly or in its effect upon the surgery of civil life. This is indicated by such chapter headings as the following: "Organization and Administration of the Medical Department of the United States Army in War"; "Organization and Administration of the Medical Department of the United States Navy in War"; "Surgery in a Fighting Ship"; "'Traumatic' Hysteria including so-called 'Shell Shock'"; "The Bacteriology of War Wounds"; "Gunshot Fractures"; "The Pathology of Gunshot Wounds and other Injuries of the Nervous System"; "Military Surgery of Joints"; "Military Orthopedic Surgery," and "Military Surgery of the Vascular System."

The entire volume will undoubtedly take its place as a valuable part of a standard work on surgery which is itself quite invaluable to any one practicing surgery in any of its branches, or any specialty related to surgery.

It must seem to the roentgenologist, however, that the object of the author to "make available for the surgery of peace the lessons taught us during the war" has been quite inadequately met, so far as roentgenology is concerned. This is especially noticeable in the chapter by Ashford on "Organization of the United States Army in War." The service rendered by the *x*-ray during the war both to the internist and to the surgeon was so generally recognized that there seems to be little ground for argument on that point. The development of the bedside roentgen apparatus was carried to a high degree of perfection. Its use in assisting in the diagnosis of empyemas and numerous other complications during the influenza epidemic can hardly be overestimated. Since the war this apparatus has come into general use in civil institutions. The importance of the *x*-ray in determining the presence and in the localization of foreign bodies was so well recognized that it merits more than the casual mention accorded it. Possibly such considerations were thought to be beyond the scope of Colonel Ashford's chapter. Several pages, however, are given over to a description of portable laboratory apparatus and no mention whatever is made of portable *x*-ray apparatus. The portable *x*-ray apparatus developed by the Medical Department of the U. S. Army was a great advance over such apparatus used by other armies both in its portability and efficiency. It was used to do the unprecedented amount of *x*-ray work in evacuation hospitals, served as the *x*-ray equipment of mobile hospitals, and even some field hospitals, such as those with the 1st, 2nd and 3rd Divisions, were equipped with it and used it extensively.

The above criticism does not apply to the article on "Military Surgery of the Vascular System" by Matas. He states that "The extraction of foreign bodies from the heart, pericardium, and great vessels constitutes one of the crowning triumphs of surgery in the late war." This was due to two factors—the greater frequency with which artillery projectiles and explosive shells were used and the "more systematic and routine examination of thoracic organs by *x*-ray, not only radiographically, but radioscopically, which has revealed the presence of projectiles in the heart, pericardium, and great vessels where their presence was not even suspected." Ombredanne and Ledoux-Lebard are quoted to the effect that examination of French sources shows a total of 2,000 extractions of projectiles made with assistance of radiographic and other localizing apparatus, with failure to extract the bodies in only three cases. It is impossible at the present time to give an estimate of operations on the heart for extraction of foreign bodies in all the armies, but accessible reports are sufficient to prove that "a deliberate, well planned surgical operation, especially in qualified hands, can be performed with a fair prospect of success."

Numerous cases are mentioned of migration of foreign bodies from the heart chambers into the blood vessels, both through arteries and veins, and also of migration from the vessels with lodgment in the heart.

Summary of the lessons bearing upon surgery of heart in general and upon extraction of foreign bodies in particular is as follows:

1. The indispensable association and collaboration of the radiologist with the surgeon for diagnostic and surgical purposes.
2. The proved efficiency of this combination has added vastly to the safety of intra-thoracic manipulations and to procedures for the extraction of foreign bodies which hitherto had been regarded as largely impracticable.
3. Modifications in the technique of thoracotomy which, utilizing the older suggestions and methods, have been revised and extended in the light of a new and larger experience.
4. The disregard of the pleura and of the risks of acute surgical pneumothorax, contrary to all preconceived notions of the gravity of this complication in antebellum days.

The radiologic peculiarities of projectiles in the heart are discussed. Radioscopy is preferable to radiography. In the auricular cavities according to Laurent of Brussels, M. Barnet, and Ledoux-Lebard, the foreign body has a whirling or oscillatory movement and exhibits very rapid and incessant motion. In the ventricles the movements are more definitely linear or pendulum-like in character. The movement of missiles in the myocardium is characteristic. One motion is vertical and the other horizontal and quite invariable, in contrast to the variable movements of a foreign body in one of the heart cavities.

It is impossible within the limits of this review even to touch upon many of the points discussed in this article. The entire section merits very careful study by the surgeon and roentgenologist.

In the chapter by Pool on "Military Surgery of the Joints" is the following paragraph:

The success of the operation depends largely upon the thoroughness of the roentgenologist's examination and the accuracy of his findings. His report should be made according to a definite system. The following routine has been found the most satisfactory.

"Anatomic site and size of each foreign body in millimeters, depth in millimeters, position of the part, if it is not in the anatomic position; bone lesions. For instance, 'Right knee, FB 10 x 15 mm., 50 mm. in depth, under the point marked on the skin, the limb being in 45 degrees outward rotation; comminuted fracture of internal condyle, no displacement."

In the chapter on "Orthopedic Surgery of Civil Life" is a paragraph on *x*-ray diagnosis of tuberculous bone and joint disease and on page 614 a description of the *x*-ray appearances in rickets.

It is to be hoped that the forthcoming volume of the *Surgery* will contain some account of the *x*-ray work done during the war, along many other lines, comparable to that in the section by Matas on "Military Surgery of the Vascular System."

A. C. CHRISTIE.

ROENTGEN INTERPRETATION; A Manual for Students and Practitioners. By George W. Holmes, M.D., and Howard E. Ruggles, M. D. Second Edition. Pages 228. Illustrations 184. Price $3.25. Lea & Febiger, Philadelphia and New York, 1921.

This book has been entirely rewritten and much has been added to the text. Illustrations have also been added. The quality of the paper used in the present edition is much better than in the first, and this greatly enhances the illustrations. The table indicating the appearance of centers of ossification is of extreme interest. The chapter dealing with heart examinations describes the method in use at the Massachusetts General Hospital for the past five years and should be in everyone's possession. The illustrations are good.

TRANSLATIONS & ABSTRACTS

WITHERS, SANFORD. Carcinoma of the Eyelids Treated with Radium. (*Am. J. Opth*, January, 1921.)

Eight cases are reported as representative of over one hundred similar cases. In most of the cases, from 25 to 50 mg. of radium were used, filtered by the glass capsule wall and 0.2 to 0.3 mm. of silver and 0.5 to 1.0 mm. of gum rubber. The surrounding tissues were protected by lead. In those cases where it was imperative to protect the globe and the ocular conjunctiva, Dr. Withers used oval lead screens, molded to fit the globe. These were dipped in melted paraffin, and were introduced after the instillation of a few drops of liquid vaseline. The total dosage varied from 500 to 900 mg. hours; the dosage per square centimeter of tumor surface ranged between 60 and 500 mg. hours. Pathologically these growths of the lids are made up of basal cells, with little stroma, and are relatively benign. In the presence of scar tissue, which breaks down easily under radiation, the results are less favorable. The author calls attention to the fact that cataracts disappear under radium, and that cautery doses of radium remove pterygia. The sclera is very resistant, even to cautery doses of radium, and the conjunctiva reacts more quickly and is more rapid in its repair than the epithelium of the eyelids. In general radium is the method of choice in the treatment of carcinoma about the eyelids.

LOWELL S. GOIN

QUICK, DOUGLASS. Clinical Results of Treatment of Nerve Tissue Tumors by Radium. (*Proc. N. Y. Neurol. Soc.; J. Nerv. Ment. Dis.*, February, 1921.)

The general opinion is that pressure symptoms due to pituitary tumors may be relieved by the use of radiation. Three cases are reported, of which one died and two were improved. Neurosarcoma is a discouraging condition. A given area may be destroyed but recurrence may take place elsewhere along the course of the nerves—not necessarily by continuity. Surgery and radium should be judiciously combined; operation should not be resorted to unless radium can be buried in the tumor if it is found possible. Two cases, one of a cerebral neoplasm successfully treated with radium, and one of an anaplastic glioma with improvement are reported.

L. S. G.

HOUDMONT, H. AND DAUTREBANDE, L. The Radioscopic Examination of the Heart. (*Arch méd. belges*, December, 1920.)

The image obtained by simple radiography is deformed by distance, by the angle of entry of the central ray, and by the pulsations of the heart. It is useless except for verification of position, pericardial lesions, or in examination for aneurysm.

Teleradiography gives a fairly exact image but is rather difficult, requiring powerful installations. Stereoscopic plates of the heart have no value. Orthodiagraphy is the method of choice. Two methods are described. Examination is carried out with the patient in various positions in relation to the screen. Each part of the heart corresponds to a position in which it may be studied with the greatest facility. Examination in the oblique position affords a means of study of parts of the heart inaccessible to ordinary clinical methods.

In functional disorders of the heart, emphasis is laid on the necessity of excluding such conditions as pleural adhesions, encysted pleuisy or large colonic or gastric gas accumulations. A number of charts for comparative measurement are included. The area of each ventricle may be calculated by the reconstruction of the interventricular and the auriculoventricular septa. Emphasis is placed on the importance of the angle of disappearance of the apex behind the vertebral column, and the left ventricle is thus measured. The normal angle of disappearance is 30 degrees. A resumé of the findings in the various organic heart lesions follows. The authors conclude:

(1) *X*-Ray examination of the heart must become a more regular part of the study of the heart.

(2) Radiographs are practically useless; orthodiagraphic calculation offers the only information of any value.

L. S. G.

Eden, T. Watts, and Provis, F. Lionel. A Record of Seventy-six Cases of Uterine Fibroids and Chronic Metritis Treated by the X-Rays. (*Lancet*, Feb. 12, 1921.)

The cases presented include 46 cases of uterine fibroids and 30 cases of chronic metritis. About 10 per cent of the cases were less than forty years of age. The cases were selected on the basis of age, size of the tumor, character of the hemorrhages, degree of anemia, and the presence of complications.

They have rarely (8 cases) treated patients less than 38 years old, wishing to conserve the ovarian secretion in patients who were younger. Tumors which exceeded the level of the umbilicus in height were rejected. In cases of irregular and interval bleeding the uterus should be first explored to exclude malignancy. Patients profoundly ex-sanguine were advised to submit to hysterectomy, as the first and second treatments may be followed by increased bleeding. Inflammatory disease, malignancy, and a degenerative tendency in the tumor were considered contra-indications for treatment. The cases for chronic metritis were so labelled for convenience, if no marked enlargement or irregularity in outline of the uterus could be detected.

The authors used from 20 to 30 ma. minutes with a water-cooled tube backing up 8 or 9 inches, and with filtration of 3 mm. of aluminum, and a loofah sponge enclosed in a chamois leather bag with four layers of satrap paper. Six or eight areas on the anterior abdominal wall and four on the posterior wall are irradiated. This dose is not repeated until three weeks have elapsed. The most advantageous time for treatment is shortly after a menstrual period. Nervous symptoms attendant upon the artificial menopause thus produced seemed to be less severe than in the normal menopause.

The authors conclude:

(1) *X*-Ray treatment is the method of choice for uncomplicated cases of severe hemorrhage due to metritis, or other conditions in which neoplasm is not present, and in—

(2) Fibroids not exceeding in size the level of the umbilicus, if the patient is over 38 years old, if the hemorrhage is the regular monthly type and if there are no contra-indications.

(3) All cases should be submitted to a careful gynecological examination before *x*-ray treatment is administered.

(4) The risk of failure with *x*-ray treatment is negligible with properly selected cases.

L. S. G.

Ewing, James. The Structure of Nerve Tissue Tumors with Reference to Radium Therapy. (*Proc. N. Y. Neurol. Soc.; J. Nerv. & Ment. Dis.*, February, 1921.)

The structural characters which determine susceptibility to radiation are a cellular character, an undifferentiated form of the cells, rapid growth with an abundance of mitoses, vascularity (especially when due to abundance of delicate capillaries), and the absence of much inter-cellular substance. Neurofibroma might be affected by radium, especially if the radium is applied directly to the tumor. True angio-endotheliomata occur in the rare diffuse sarcoma of the spinal meninges, and should be susceptible to radium. Angiosarcoma should be markedly influenced by radium, since its nutrition is unstable, but whether slow and safe regression can be accomplished, especially with bulky tumors, is doubtful. Glioma presents most of structural features that favor radio-susceptibility. Primary carcinoma of the brain has a structure indicating a high degree of susceptibility to radium. Hypophyseal struma with acromegaly has been definitely influenced by *x*-rays directed through the temporal regions.

L. S. G.

Frank, Louis. Carcinoma in the Cervical Stump after Supravaginal Hysterectomy; and the Radium Treatment of Carcinoma of the Cervix. (*Am. J. Surg.*, Vol. xxxiv, No. 6.)

The coincidental development of cervical and corporeal carcinoma is unusual. The problem of etiologic relationship between carcinoma and fibromyomata remains unsolved, but it is interesting to note that uterine carcinoma occurs in women who have fibromyomata five times as frequently as in those who have no such condition. The development of carcinoma in the cervical stump after supravaginal hysterectomy is rare, less than eighty cases having been recorded in the world's literature. Radical surgery has produced few cures after the pelvic viscera have become involved in a carcinomatous process. According to Janeway, an elaborate search of the United States discovered only 61 women operated on between 1911 and 1916 who had been cured of cervical carcinoma. The writer cites 38 cases (three of which are reported in detail) of carcinoma of the cervix treated with radium. The three detailed cases received doses of 1200, 2400 and 3600 mg. hours respectively. The dosage at each application was in one case 600 mg. hours and 1200 in each of the two others. Of the thirty-eight cases treated, 18 are well (some of them for two years), 4 show no local evidence of disease but are not well, 11 have died, and 6 cannot be traced.

L. S. G.

Stevenson, Walter C. The Effects of Radium Treatment on War Injuries in the Neighborhood of Nerves. (*Brit. Med. J.*, June 26, 1920.)

The writer reports twelve cases of old nerve injuries markedly improved by radium treatment. He concludes that while radium cannot benefit gross nerve lesions, it does improve the nutrition in the area supplied by injured nerves, and it appears to aid and hasten the return of function in a limb after milder degrees of nerve trauma.

L. S. G.

Ulrici, H. So-called Hilus Tuberculosis. (*Beitr. z. Klin. d. Tuberk.* October 23 1920, xlvi, l.)

In pulmonary tuberculosis in the adult, the localization of the disease in the bronchial glands which is invariably present has almost always regressed to such a degree as to be seldom demonstrable either by clinical, physical-diagnostic or radiologic resources. As a rule only foci of lime are recognizable as such in the plate. In children conditions are quite otherwise. Here the bronchial glands are of great significance in the genesis of pulmonary tuberculosis. In adults there is practically no pulmonary tuberculosis which has originated in the hilus. The shadow pattern in the plate which has given rise to the contrary impression is due to a confluence cirrhosis of the hilus area, or to a caseous pneumonia which begins centrally—for this latter condition indeed the shadow is pathognomonic. In the adult, pulmonary tuberculosis begins almost invariably in the apex or sub-apex, not only in the side of the hilus originally, but in the opposite side as well. The broadening of the isolated hilus shadow and the reinforced outlines of the lung have nothing to do with pulmonary tuberculosis proper.

Ledoux and Caillods. Sacralization of the Fifth Lumbar Vertebra. (*Presse méd.*, Par., Feb. 13, 1921, xxix, 13.)

In the space of a few months the authors have recognized by radiography no less than 7 cases in which the last lumbar vertebra was incorporated with the sacrum. Nové-Josserand, the well known orthopedist, had called attention to this condition as a cause of various painful manifestations in the lower extremities. He however regards it as very rare while the authors think it may be fairly common, judging from their own experience. The characteristic *x*-ray find is a considerable and symmetrical enlargement of the transverse process of the fifth lumbar vertebra. The shadow of this process suggests the tail of a fish, while when both are considered the resemblance to a butterfly's wings is mentioned. The enlarged process is in contact for a considerable extent with the ilium and upper border of the wing of the sacrum. Compared with the radiograms of Nové-Josserand the condition seen by the authors seems more advanced. Since the last lumbar vertebra is consolidated with the sacrum the enlarged and bifid transverse process suggests an accessory wing of the sacrum superposed on the normal wing. Embryology teaches us that the latter is really the transverse process of the first sacral vertebra. As a result of the malformation the normal lumbo-ilio-sacral interspace through which passes the fifth lumbar nerve is not only much reduced in size but becomes a sort of sacral foramen. While the symptoms do not usually appear in childhood, one of the author's patients was but five years old. The period at which the ossification of the lumbar vertebra to the sacrum occurs has not been determined. The original ossification of the spine should be complete by the ninth year, while the so-called secondary ossification extends from the ages of fifteen or sixteen to those of twenty-two to twenty-five. This phenomenon has been associated with a disturbance of secondary ossification, but the case of the child of five appears to invalidate this view.

LEHMANN, J. C. Carcinoma Dosage, with Especial Consideration of Carcinoma of the Breast. (*Zentralblatt für Chirurgie*. Leipzig. Vol. xlvii, No. 13, p. 290, March 27, 1920.)

The author points out that to-day practically every surgeon gives patients with carcinoma of the breast prophylactic raying following an operation. He has followed this method for the last seven years and freedom from recurrences for a period of three years has increased. In cachetic patients carcinomas are in no way sensitive to roentgen rays while in senile persons carcinomas are frequently of slow growth and easier to check with roentgen rays.

In chancroid of the lip considerably more than 100 per cent of the erythema dose is required; radium will be usually more efficacious than roentgen rays.

While some progress has been made in the use of the roentgen rays as applied to carcinoma of the breast, the author warns against being over-jubilant lest the method be brought into discredit.

ROBERTS, J. E. H. Oxygen Inflation of the Peritoneal Cavity for Radiographic Purposes. (*Brit. M. J.*, p. 742, Nov. 13, 1920.)

The method of distending the peritoneal cavity by oxygen gas, which was introduced by Weber in Germany, followed by Rautenberg and Goetze in Germany, Stewart and Stein in America, and Alesandrini in Italy has proved to be of great value in exact clinical diagnosis. By allowing the separation of the liver and spleen from the diaphragm, it has enabled the outlines of these organs to be seen for the first time. By compressing and displacing the empty intestines it enables the other solid viscera and abdominal tumors to be examined.

The objections to the method are largely theoretical and no ill consequences have occurred in the fifty cases the author has inflated, nor in any of the many cases of which published records exist.

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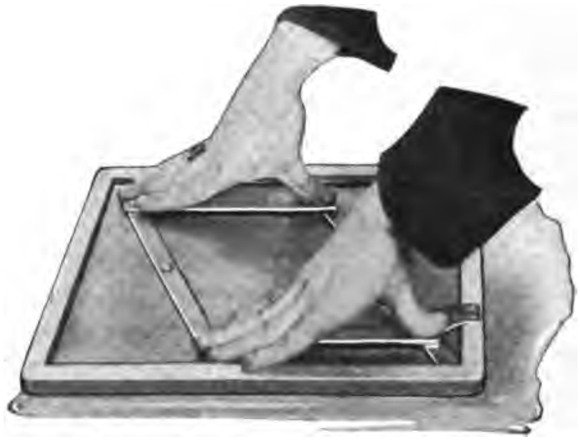

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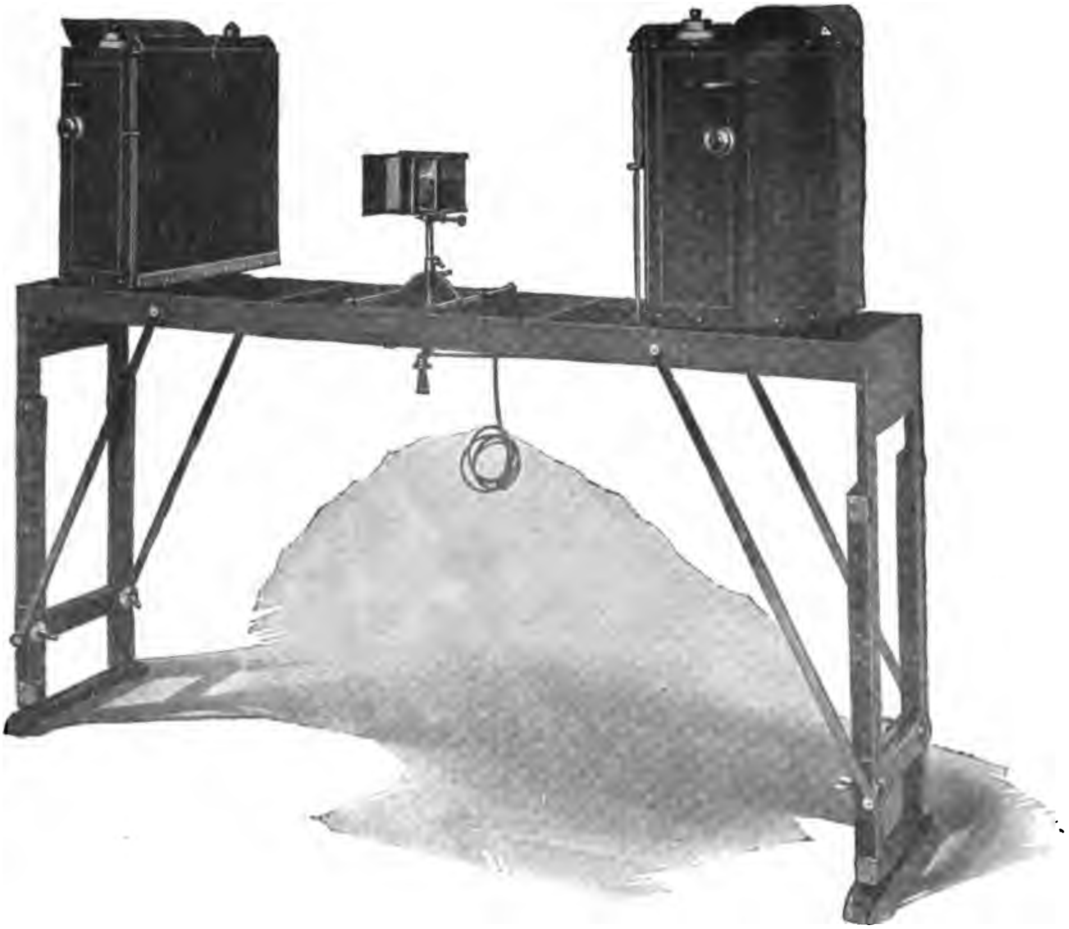

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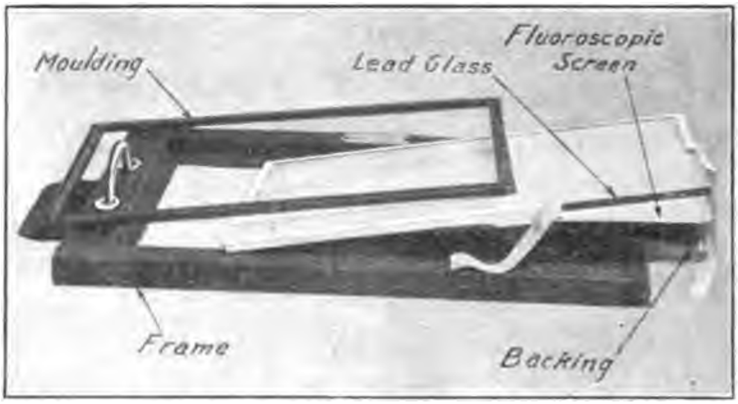

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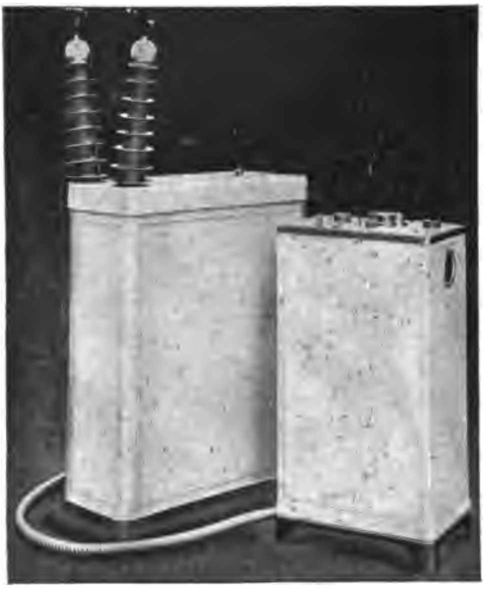

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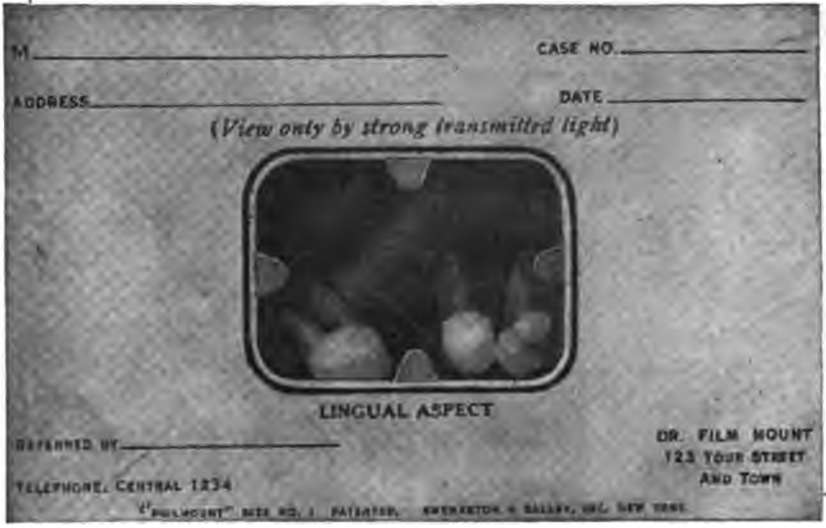

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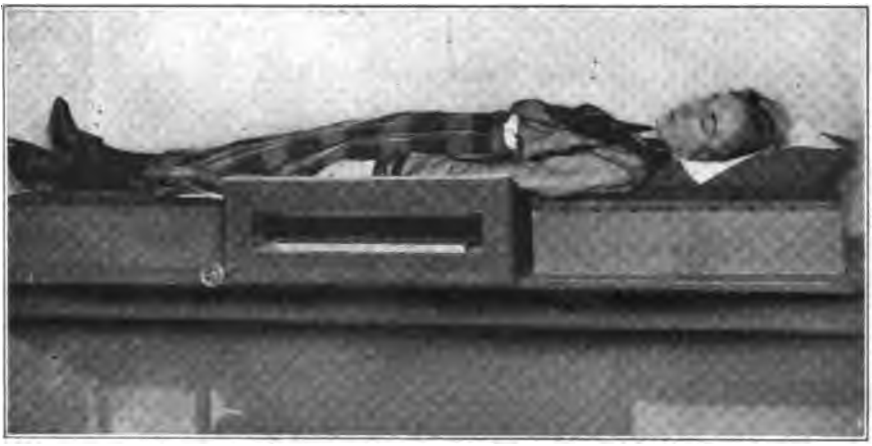

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